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MARYLAND

FINAL REPORT ON EVALUATION OF BLAST EFFECTIVENESS

OF VARIOUS HEI EXPLOSIVE FILLERS (U)

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OF VARIOUS HEI EXPLOSIVE FILLERS

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Sp-3 PLO'Neil/vl
9 March 1956

FINAL REPORT ON EVALUATION OF BLAST EFFECTIVENESS OF VARIOUS HEI EXPLOSIVE FILLERS

TWENTY-FIFTH REPORT ON PROJECT NO. TS1-48 (U)

DATES OF TEST: July 1954 to October 1955

OBJECT

To determine the relative blast effectiveness of different explosive fillers for aircraft ammunition.

SUMMARY

This report evaluates the results of static firing tests of various HEI filler compositions. Firing was conducted in the APG 4' Blast Cube using Shell, 30mm, T306E10 as a carrier, and in B-29 wing-tip sections using Shell, 20mm, T282E1 as a carrier.

CONCLUSIONS

A. After comparison of all explosive mixes fired in this test, RDX/Aluminum 65%/35% appears to be the optimum filler for maximum blast damage both at sea level and at 60,000 feet simulated altitude. However, it should be noted that this mix does not hold a marked superiority over other explosives fired but merely a small statistical edge.

B. No attempt to predict blast results of firing against aircraft type structures should be made as an extension of results obtained in blast cube firing, as the blast cube is intended solely as an instrument to test relative effectiveness of various explosive mixtures at low altitudes and under restricted conditions.

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RECOMMENDATIONS

It is recommended that:

A. Comparative static and dynamic testing against aircraft type structures for blast, fragmentation, and incendiary effect be conducted using the following mixtures:

RDX-AL	65/35
Torpex	30/35/35
HBX-6	
MOX-2B	

B. A more discriminating blast cube scoring system be developed. (See Appendix E, Section 2).

C. Care should be exercised in the use of results of tests fired in the blast cube. The cube is strictly an instrument for the testing of relative blast effect of various explosive mixes under restricted conditions, and is not designed to act as a gage to predict the results of firing against aircraft type structures.

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I INTRODUCTION

A. DISCUSSION

1. During the past two years the necessity for more exact performance data was recognized in order to determine the optimum explosive filler to be used in aircraft ammunition which would, in turn, produce the greatest blast, fragmentation and incendiary damage from sea level to 60,000 feet altitude. A decision was made to make comparative blast evaluations of several experimental HE fillers and then to utilize the most promising of these explosives in further investigation of fragmentation and incendiary properties.

2. Aberdeen Proving Ground was selected as the agency to conduct blast evaluation tests utilizing the APG four (4) foot blast cube and scoring technique.

B. REFERENCES

1. Letter file OO 471/2140 (30mm) (c), APG (c)471/990, dated 14 October 1952, Subject: Ammunition for 30mm Guns, T121 and T182, Project TS1-48, D/A Priority 1-A.

2. Firing Record No. P-60189, Project TB3-0226A, Blast Effect of Bare Charges on Aircraft Structures at Various Low Pressures Simulating High Altitudes.

II DESCRIPTION OF MATERIAL

A. Test Ammunition

1. Four Hundred Thirty-Six (436) Shell, HEI, 30mm, T306E10 w/T263E8 Fuze locally modified for static detonation by M-36 blasting cap, and loaded as follows:

APG COMP. NO.	BASIC EXPLOSIVE	NOMINAL MIXTURE		LOADING TECHNIQUE	NO. OF ROUNDS
Phase 1					
1	Tritonal	20/80	AL/TNT	Cast	20
2	AL 24-3	20/27/40	AL/TNT/RDX (20/67 AL/Comp B)	Cast	20
3		10/33/49	AL/TNT/RDX (10/82 AL/Comp B)	Cast	20
4	HBX-1	17/38/40	AL/TNT/RDX	Cast	19
5	HBX-3	35/29/31	AL/TNT/RDX	Cast	20
6	HBX-6	21/29/45	AL/TNT/RDX	Cast	19
7	Torpex (M)	30/35/35	AL/TNT/RDX	Cast	20
8	Comp B	40/60	TNT/RDX	Cast	20
9	Omitted from test - same as Comp #10			Cast	
10	HTA-1	35/29/31	AL*/TNT/RDX	Cast	20
11	MOX-2B	AL 54%, NH_4ClO_4/TNT 90/10 40% RDX/Wax 97/3 6% (calcium stearate 2%, graphite 1% added) added		Press	20
12	RDL-AL	65/35	RDX/AL	Press	20
13	Torpex	30/35-35	AL/TNT/RDX	Press	20
14	Comp B	40/60	TNT/RDX	Press	20
15	TNT	100% TNT		Cast	20

APG COMP. NO.	BASIC EXPLOSIVE	NOMINAL MIXTURE	LOADING TECHNIQUE	NO. OF ROUNDS
Phase 3				
A	RDX	100% RDX	Press	20
B	RDX-AL	90/10 RDX/AL	Press	20
C	RDX-AL	80/20 RDX/AL	Press	20
D	RDX-AL	70/30 RDX/AL	Press	20
E & 12	RDX-AL	65/35 RDX/AL	Press	10
F	RDX-AL	60/40 RDX/AL	Press	30
G	RDX-AL	50/50 RDX/AL	Press	30
Phase 4				
H	MOX-2B	(Comp. #11)	Press	8

* Atomized spherical aluminum of seive 20/200 mesh - no $Ca\ Cl_2$

Note 1 - All shell were loaded with approximately 520 gr. explosive. All shell were topped with RDX/wax 97/3 pressed 140 grains, cast 104 grains, and faced to a depth of .510"-.520" from nose of shell.

Phase 2

2. Ten (10) Shell, HEI, 20mm, T282E1 loaded with MOX-2B with Fuze M505 locally modified for static detonation by M36 blasting cap.

B. Field Test Materiel

1. Four Hundred Thirty-six (436) sheets aluminum plate (24 ST) .032" x 4' x 4'.
2. Four Hundred Thirty-six (436) sheets aluminum plate (24 ST) .040" x 4' x 4'.
3. Four Hundred Thirty-six (436) sheets aluminum plate (24 ST) .064" x 4' x 4'.
4. Four Hundred Thirty-two (432) sheets aluminum plate (24 ST) .081" x 4' x 4'.
5. Two (2) B-29 wing tip sections.
6. Four Hundred Forty-six (446) M36 blasting caps.

C. Field Test Equipment

1. 4' APG Blast Cube.
2. APG Stratosphere Chamber (no thermal control).
3. Detonator, Electric M-36A1.

III DETAILS OF TEST

A. PROCEDURE

1. Phase 1. APG Compositions #1-15 were fired for static blast effect. The round by round procedure consisted of placing a round in the geometric center of the APG Blast Cube which in turn was mounted within the APG stratosphere chamber. Approximately half of each composition lot was fired at sea level atmospheric pressure, and half at a pressure equivalent to 60,000 ft. altitude. After each round, the stratosphere chamber was opened, the round scored by the proof director, (See Appendix E for blast cube procedure and scoring) and the next round readied for detonation.

2. Phase 2. Examination of the results of Phase 1 showed a discrepancy between actual results and results predicted from previous static firings of cased and bare charges in aircraft type structures. Consequently Phase 2, not originally planned for, was included in the test. In place of the Blast Cube, left and right B-29 wing tip sections were placed within the stratosphere chamber and five (5) 20mm rounds were statically detonated at various strategic points within the structure, both at sea level and 60,000 ft. simulated altitude pressures. (See Appendices E and G for test set-up and Blast Cube Analysis).

3. Phase 3. After evaluation of the results obtained in Phase 1, it was determined to conduct further static blast investigations of the various explosive mixtures receiving the highest scores as determined in Phase 1. One hundred (100) rounds were fired in this phase using the same procedure outlined in Phase 1 above.

4. Phase 4. This phase was fired as an experimental attempt to explain discrepancies between results obtained in Phase 1 and Phase 2. Eight rounds were fired, four at sea level pressure and four at a pressure corresponding to 60,000 ft. altitude. Procedure was the same as outlined under Phase 1 except half of the rounds were fired in the Blast Cube with the .081" aluminum plate left off (giving, in effect, a cube with one side open), and the other four rounds were fired with the conventional closed cube, these last to be used as a standard (See Appendix E, Section 3).

B. RESULTS

1. Phase 1. All explosive compositions tested in the Blast Cube with the exception of TNT, showed higher average scores at 60,000 ft. than at sea level. Five (5) explosive mixes showed high altitude test score averages greater than 30 with RDX/AL, 65/35, being the most promising with an average score of 37.9.

2. Phase 2. Static detonation of 20mm rounds, within B-29 wing tips on the other hand, showed somewhat less damage at 60,000 ft. than at sea level.

3. Phase 3. Firings of various mixtures of RDX/AL proved 65/35 RDX/AL to be the highest scoring mixture at 60,000 ft. simulated altitude in the Blast Cube.

4. Phase 4. Firing with one side of the Blast Cube left open showed a definite trend towards lower scores at 60,000 ft. than at sea level whereas a completely closed cube resulted in higher scores at 60,000 ft. than at sea level (See Appendix B, Section 3).

C. OBSERVATIONS

1. It should be noted that consistent results when firing over an extended period of time were not obtained. When RDX/AL 65/35 was fired in Phase 1, scores of 37.8 at 60,000 ft. and 32.9 at sea level were obtained. Both of these scores were the highest recorded at these two altitudes. However, the firing results of Phase 3, using the same explosive mixture, showed a 60,000 ft. altitude score of 39.2. In a similar situation RDX/AL 50/50 fired at 60,000 ft. simulated altitude on 11 and 12 August 1955 showed an average score of 32.8 for five (5) rounds whereas the same mixture fired on 3 and 4 August 1955 showed an average score of 38.8 for fifteen (15) rounds.

2. Results of Phase 4 in which rounds were detonated with one side of the Blast Cube open showed a lower score for rounds fired at 60,000 ft. than for rounds fired at sea level. This is an inversion of the results obtained in Phases 1 and 3 but parallels to results obtained in Phase 2 where firing was conducted within an aircraft type structure. (See Appendix E)

IV CONCLUSIONS

A. An explosive mixture of RDX/AL 65/35 appears to be the optimum filler for maximum blast damage from HEI aircraft ammunition. These results are applicable only to the 4' APG Blast Cube or targets whose blast vulnerability may be predicted from this cube.

B. Blast effect in an aircraft type structure cannot be predicted by an extension of results obtained in blast cube firing under the existing procedure. (See Appendix E, Section 3).

V RECOMMENDATIONS

A. Comparative static and dynamic testing against aircraft type structure to determine relative blast, incendiary and fragmentation properties should be conducted utilizing the following explosive mixtures:

RDX-AL (65/35)
Torpex 30/35/35
HBX-6
HOX-2B

B. A more definitive scoring system should be employed in blast cube testing at simulated altitudes. The existing system allows for too little latitude in the scoring of individual rounds. (See Appendix E)

C. It should be noted that the blast cube is designed only as an instrument to test relative blast effect of various explosive mixes under restricted conditions and consequently, no attempt should be made to extend results of blast cube firing with the object of predicting blast effect of explosives fired in aircraft type structures.

Paul L. O'Neil

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APPROVED:

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H. L. Rosenberg

H. L. ROSENBERG
Chief, Terminal
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APPENDICES

APPENDIX A

Letter file 00471/2140 (30MM) (C), APG (C) 471/990, dated 14 October 1952, Subject: Ammunition for 30mm Guns, T121 and T182 - Project T81-48, D/A Priority 1-A.

APG(o)471/990
00 471/2140(c) (30mm)

Office of the Chief of Ordnance
Washington, D. C.

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14 October 1952

SUBJECT: Ammunition for 30mm Guns, T121 and T162 - Project T31-46, D/A Priority 1-A

TO: Commanding General
Aberdeen Proving Ground, Md.

1. Confirming discussion with Mr. Rosenberg of your station, it is requested that Aberdeen Proving Ground, based upon results of firings against aircraft and simulated aircraft targets, submit comments and recommendations concerning the design of improved high capacity, high explosive shell, together with matching AP-I and practice cartridges, for use in the 30mm guns, T121 and T162.

2. The present family of ammunition for the T121 gun is based upon a 420 grain (approximately) projectile, to be fired at 1200 rpm at a muzzle velocity of 2,000 fps and a maximum allowable average chamber pressure of 40,000 psi (piezo). The complete round length should not exceed 7.814". It is anticipated that the T121 gun will be utilized for bomber tail defense purposes.

3. The present family of ammunition for the T162 gun is based upon a 1200 grain (approximately) projectile, to be fired at 1200 rpm at a muzzle velocity of approximately 3,000 fps and a maximum allowable average chamber pressure of 40,000 psi (piezo). The complete round length should not exceed 7.814". The T162 gun is intended for early installation in fighter aircraft. To be compatible with aircraft performance, the ammunition for this installation must be so designed as to possess satisfactory ballistic stability and safety for forward firing from aircraft at sea level at Mach 1.4, and to give optimum performance at altitudes of 20,000 to 60,000 feet at Mach 1.0.

4. The basic objective of the study should be an increase in the terminal effectiveness of the HE (or HEI) cartridges without serious degradation of ballistic characteristics. Since, in order to meet planned installation and service dates for the T162 gun, design of the ammunition for this gun must be available for release to production by 30 June 1953, first consideration should be given to that ammunition.

5. If feasible, actual firings against aircraft should be conducted with proposed designs.

BY ORDER OF MAJOR GENERAL T. M. [illegible]:

[illegible]
Colonel, Ord Corps
Assistant

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APPENDIX B

Description of Materiel and

Round-by-Round Data Sheets

Section 1	-	Phase 1
Section 2	-	Phase 3
Section 3	-	Phase 4

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Section 1 - Phase 1

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Phase 1

A. Test Ammunition

Two hundred seventy-eight (278) Shell (HEI) 30mm, T306E10, w/T263E8 Fuze locally modified for static detonation by M-36 blasting cap and loaded as follows:

Ammunition Data

APG COMP. NO.	BASIC EXPLOSIVE	NOMINAL MIXTURE	LOADING TECHNIQUE	NO. OF ROUNDS
1	Tritonal	20/80 AL/TNT	Cast	20
2	AL 24-3	20/27/40 AL/TNT/RDX(AL/Comp B)	Cast	20
3		10/33/49 AL/TNT/RDX(AL/Comp B)	Cast	20
4	HBX-1	27/38/40 AL/TNT/RDX	Cast	19
5	HBX-3	35/29/31 AL/TNT/RDX	Cast	20
6	HBX-6	21/29/45 AL/TNT/RDX	Cast	19
7	Torpex (M)	30/35/35 AL/TNT/RDX	Cast	20
8	Comp B	40/60 TNT/RDX	Cast	20
9	Omitted from Test - same as Comp #10		Cast	
10	RTA-1	35/29/31 AL*/TNT/RDX	Cast	20
11	MOX-2B	AL 54%, NH_4 ClO_4/TNT 90/10 40%, RDX/WAX 97/3 6%, Calcium stearate 2%, graphite 1%.	Press	20
12	RDX-AL	35/65 AL/RDX	Press	20
13	Torpex	30/35/35 AL/TNT/RDX	Press	20
14	Comp B	40/60 TNT/RDX	Press	20
15	TNT	100% TNT	Cast	20

* Atomized spherical aluminum of seive 20/200 mesh - No $CaCl_2$

Note 1 - Compositions No. 1-10 and 15 were cast loaded. Nos. 11-14 were press loaded. All shells were loaded with approximately 520 gr. explosive. All shells were topped with RDX/wax 97/3 pressed 140 gr., cast 104 gr. and faced to a depth of .510"-.520" from nose of shell.

Note 2 - All rounds equipped with T263E8 Fuzes locally modified for static detonation.

B. Field Test Materiel

1. Two hundred seventy-eight sheets aluminum plate (24 ST) .032" x 4' x 4'.
2. Two hundred seventy-eight sheets aluminum plate (24 ST) .040" x 4' x 4'.
3. Two hundred seventy-eight sheets aluminum plate (24 ST) .064" x 4' x 4'.
4. Two hundred seventy-eight sheets aluminum plate (24 ST) .081" x 4' x 4'.
5. Two hundred seventy-eight M-36 blasting caps.

C. Field Test Equipment

1. 4' APG Blast Cube.
2. APG Stratosphere Chamber (no thermal control).
3. Detonator, Electric, M36A1.

ORDNANCE CORPS
ABERDEEN PROVING GROUND
MARYLAND

Subject: Static Blast of 30mm HEI Explosive Fillers

PROOF SHEET — CONFIDENTIAL

Page 1 — Page 1

AFG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
1.	1	4334	1001	0000	0000	16	Sea level
	2	3434	1101	0000	0000	17	Sea level
	3	4334	1101	0000	0000	17	Sea level
	4	3444	1122	0000	0000	21	Sea level
	5	3434	0101	0121	0000	20	Sea level
	6	3333	5333	0000	0000	26	Sea level
	7	4435	1001	1000	0000	19	Sea level
	8	4434	1011	0000	0000	18	Sea level
	9	4333	3343	0000	0000	26	Sea level
	10	4435	1111	0000	0000	20	Sea level
	11	5454	3333	0000	0000	30	60,000 ft.
unfair	12	5010	0000	0000	0000	5	60,000 ft.
	13	5455	1101	0000	0000	22	60,000 ft.
	14	5445	0000	0000	0000	18	60,000 ft.
	15	5411	5544	0000	0000	29	60,000 ft.
unfair	16	0110	0100	0000	0000	3	60,000 ft.
	17	5555	0100	0000	0000	21	60,000 ft.
	18	5555	4000	0000	0000	24	60,000 ft.
unfair	19	0501	1000	0000	0000	7	60,000 ft.
unfair	20	1001	0000	0000	0000	2	60,000 ft.
2.	21	4334	1142	0011	1000	25	Sea level
	22	1111	1111	0000	0000	8	Sea level
	23	1111	1001	0000	0000	6	Sea level
	24	1111	0000	0000	0000	4	Sea level
	25	2232	1000	0000	0000	10	Sea level
	26	1101	1111	0000	0000	7	Sea level

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ABERDEEN PROVING GROUND

Static Blast of 30mm HEI Explosive Fillers

PROOF S... Phase 1

APG COMP NO.	RD. NO.	BLAST DAMAGE				TOTAL	ALTITUDE
		.032	.040	.064	.081		
2.	27	3444	1210	0000	0101	21	Sea level
	28	1101	1100	0000	0000	5	Sea level
	29	0000	0000	0000	0000	0	Sea level
	30	4434	2222	0000	0000	23	Sea level
	31	5554	1000	1001	0000	22	60,000 ft.
	32	5545	0000	0000	0000	19	60,000 ft.
	33	5555	3233	0000	0000	31	60,000 ft.
	34	5555	0000	0000	0000	20	60,000 ft.
	35	4454	4454	0000	0000	54	60,000 ft.
	36	5555	0000	0000	0000	20	60,000 ft.
	37	4555	1000	0000	0000	20	60,000 ft.
	38	5555	0000	0000	0000	20	60,000 ft.
	39	5555	1500	0000	0000	26	60,000 ft.
	40	5555	0000	0000	0000	20	60,000 ft.
3.	41	2102	1001	0000	0000	7	Sea level
	42	4222	0111	0000	0000	13	Sea level
	43	2222	1101	0000	0000	11	Sea level
	44	2112	2222	0000	0000	14	Sea level
	45	1111	1010	0000	0000	7	Sea level
	46	1101	1110	0000	0000	6	Sea level
	47	1111	1101	1000	0000	8	Sea level
	48	1111	1111	0000	0000	8	Sea level
	49	0001	1001	1000	0000	4	Sea level
	50	1101	1001	0000	0000	5	Sea level
	51	4555	0100	0000	0000	20	60,000 ft.
	52	5555	0000	0000	0000	20	60,000 ft.

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ABERDEEN PROVING GROUND

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Static Blast of 30mm HEI Explosive Fillers

Phase 1

APG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
3.	53	4554	0100	0000	0000	19	60,000 ft.
	54	5555	0000	0000	0000	20	60,000 ft.
	55	5555	0101	0000	0000	22	60,000 ft.
	56	4555	0000	0000	0000	19	60,000 ft.
	57	5555	1000	0000	0000	21	60,000 ft.
	58	4455	0000	0000	0000	18	60,000 ft.
	59	0200	0000	0000	0000	2	60,000 ft.
	60	4545	0000	0000	0000	18	60,000 ft.
4.	61	3454	1131	0000	0000	22	Sea level
	62	4434	2232	1211	0000	29	Sea level
	63	4444	1141	0000	0000	23	Sea level
	64	3444	2342	0000	0000	26	Sea level
	65	3424	3442	0000	0000	26	Sea level
	66	4454	1122	0000	0000	23	Sea level
	67	4444	2233	0000	0000	26	Sea level
	68	4454	2332	1000	0000	28	Sea level
	69	4343	2332	0000	0000	24	Sea level
	70	4443	1141	1100	0000	24	Sea level
	71	3343	3343	2001	0000	29	Sea level
	72	4444	2243	0000	0000	27	Sea level
	73	5555	0100	0000	0000	21	60,000 ft.
	74	5555	3455	0000	0000	37	60,000 ft.
	75	5544	4455	0000	0000	36	60,000 ft.
	76	5555	4444	0000	0000	36	60,000 ft.
	77	5555	4554	0000	0000	38	60,000 ft.
	78	4555	4444	0000	0000	35	60,000 ft.

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Static Blast of 30mm HEI Explosive Fillers
Phase 1 Page 4

PROOF SHEET

APG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
4.	79	5555	0101	0000	0000	22	60,000 ft.
5.	80	4454	2342	1000	0000	29	Sea level
	81	4454	2332	1100	0000	29	Sea level
	82	4444	2332	0010	0000	27	Sea level
	83	4444	1132	0110	0000	25	Sea level
	84	4444	3343	0000	0000	29	Sea level
	85	4454	4333	0010	0000	31	Sea level
	86	4444	3333	0000	0100	29	Sea level
	87	4445	3333	1221	0011	37	Sea level
	88	4445	2232	000	0000	26	Sea level
	89	4444	4444	0000	0000	32	Sea level
	90	5555	4000	0000	0000	24	60,000 ft.
	91	4555	1411	0000	1100	28	60,000 ft.
	92	5555	4444	0000	0000	36	60,000 ft.
	93	4555	4544	0000	0000	36	60,000 ft.
	94	5555	0501	0000	0000	26	60,000 ft.
	95	5555	4555	0000	0000	39	60,000 ft.
	96	5455	4444	0000	0000	35	60,000 ft.
	97	4455	5444	0000	0000	35	60,000 ft.
	98	5555	5544	0000	0000	38	60,000 ft.
	99	5454	4444	2222	0000	42	60,000 ft.
6.	100	4444	4322	1000	0000	28	Sea level
	101	4454	2113	0000	0000	24	Sea Level
	102	4444	2332	1221	0000	33	Sea level
	103	4444	4444	0000	0000	32	Sea level
	104	4444	4333	0100	0000	30	Sea level

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AFG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
6.	105	4433	3333	1000	0000	27	Sea level
	106	4445	3311	0001	0000	26	Sea level
	107	4444	3223	1001	0000	28	Sea level
	108	4444	3333	2001	0000	31	Sea level
	109	4434	3343	2001	0000	31	Sea level
	110	5555	4444	0000	0000	36	60,000 ft.
	111	5555	5444	0000	0000	37	60,000 ft.
	112	5555	4545	0020	0000	40	60,000 ft.
	113	5545	4345	0000	0000	35	60,000 ft.
	114	4555	4444	0000	0000	35	60,000 ft.
	115	5555	4442	0000	0000	34	60,000 ft.
	116	5555	4454	0000	0000	37	60,000 ft.
	117	5555	0100	0000	0000	21	60,000 ft.
	118	5555	4445	0000	0000	37	60,000 ft.
7.	119	4444	3342	1000	0000	29	Sea level
	120	4444	3333	0001	0000	29	Sea level
	121	4444	3344	0101	0000	32	Sea level
	122	4444	3223	0100	0100	28	Sea level
	123	4444	3343	0000	0000	29	Sea level
	124	4454	3333	0001	0000	30	Sea level
	125	4444	3343	0001	0000	30	Sea level
	126	4444	2232	1 00	0000	26	Sea level
	127	4444	2243	1001	0000	29	Sea level
	128	4454	2233	0000	0000	27	Sea level
	129	5555	4544	0000	0000	37	60,000 ft.
	130	5555	4443	0000	0000	35	60,000 ft.

ORDNANCE CORPS
ABERDEEN PROVING GROUND

Test:
Static Blast of 30mm HEI
Explosive Fillers

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APG COMP NO.	RD. NO.	BLAST DAMAGE				TOTAL	ALTITUDE
		.032	.040	.064	.081		
7.	131	5555	2344	0000	0000	33	60,000 ft.
	132	5555	4444	0000	0000	36	60,000 ft.
	133	5555	4544	0000	0000	37	60,000 ft.
	134	5555	4453	0000	0000	36	60,000 ft.
	135	5555	5411	0000	0000	31	60,000 ft.
	136	5555	4423	0000	0000	33	60,000 ft.
	137	5555	2452	0000	0000	33	60,000 ft.
	138	5555	4444	0100	0000	37	60,000 ft.
8.	139	2232	2101	1000	0000	14	Sea level
	140	2233	1001	0000	0000	12	Sea level
	141	2233	1100	0000	0000	12	Sea level
	142	2233	1010	0000	0000	12	Sea level
	143	1101	1141	0000	0000	10	Sea level
	144	2232	1121	1000	0000	14	Sea level
	145	1121	2222	0000	0000	13	Sea level
	146	1101	1101	0000	0000	6	Sea level
	147	1111	1000	1000	0000	6	Sea level
	148	1211	1101	0000	0000	8	Sea level
	149	5455	1000	0000	0000	20	60,000 ft.
	150	4545	0141	0000	0000	24	60,000 ft.
	151	5555	0100	0000	0000	21	60,000 ft.
	152	5554	0010	0000	0000	20	60,000 ft.
	153	4454	0001	0000	0000	18	60,000 ft.
	154	5555	0000	0000	0000	20	60,000 ft.
	155	4455	1000	0000	0000	19	60,000 ft.
Low order	156	[illegible]	0100	0000	[illegible]	[illegible]	[illegible] ft.

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Test of:
Static Blast of 30mm HEI Explosive Fillers
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APG COMP NO.	RD. NO.	BLAST DAMAGE .022	.040	.064	.081	TOTAL	ALTITUDE
8.	157	5554	0000	0000	0000	19	60,000 ft.
	158	0000	0100	0000	0000	1	60,000 ft.
10.	159	4454	2343	1001	0111	34	Sea level
	160	4454	1221	0100	0000	24	Sea level
	161	4444	1413	1000	1000	27	Sea level
	162	4454	4343	1000	0000	32	Sea level
	163	4454	2112	0000	0000	23	Sea level
	164	4454	3233	1122	0000	34	Sea level
	165	4444	4333	0000	0000	29	Sea level
	166	4454	2232	0000	1121	31	Sea level
	167	4454	3234	2011	0000	33	Sea level
	168	4454	4333	1001	0000	32	Sea level
	169	5555	4455	0000	0000	38	60,000 ft.
	170	5455	4454	3322	0000	46	60,000 ft.
	171	5555	4454	0000	0000	37	60,000 ft.
	172	5555	4443	0000	0000	35	60,000 ft.
	173	5555	4455	0000	0000	38	60,000 ft.
	174	5555	4544	0000	0000	37	60,000 ft.
	175	4555	4544	0000	0000	36	60,000 ft.
	176	5555	4454	0000	0000	37	60,000 ft.
	177	5555	4001	2233	0000	35	60,000 ft.
	178	5545	4454	0000	0000	36	60,000 ft.
11.	179	4454	3343	0100	0000	31	Sea level
	180	4354	3333	0110	0000	30	Sea level
	181	4454	4354	1100	0000	35	Sea level
	182	4454	3333	1100	0000	32	Sea level

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Test of: Static Blast of 30mm HEI Explosive Fillers

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APG COMP NO.	RD. NO.	BLAST DAMAGE .032	.048	.064	.081	TOTAL	ALTITUDE
11.	183	4444	2234	1000	0000	28	Sea level
	184	4454	2333	0010	0000	29	Sea level
	185	4454	4344	1100	0000	34	Sea level
	186	4454	3333	1010	0000	31	Sea level
	187	5555	5554	0000	0000	39	60,000 ft.
	188	5555	4554	0000	0000	38	60,000 ft.
	189	5555	5554	0000	0000	39	60,000 ft.
	190	5555	4554	0010	0000	39	60,000 ft.
	191	5555	3555	0000	0000	38	60,000 ft.
	192	4555	5555	0000	0000	39	60,000 ft.
	193	5545	4454	0000	0000	36	60,000 ft.
	194	5555	5334	0000	0000	35	60,000 ft.
	195	4555	4554	0000	0000	37	60,000 ft.
	196	5555	2252	0010	0000	32	60,000 ft.
	197	5555	5444	0000	0000	37	60,000 ft.
	198	5555	3455	0000	0000	37	60,000 ft.
12.	199	5455	4433	1120	0000	37	Sea level
	200	5454	4343	1000	0000	33	Sea level
	201	5454	4333	1010	0001	34	Sea level
	202	5444	2233	1000	0000	28	Sea level
	203	5454	3333	1000	0000	32	Sea level
	204	2222	1221	0010	special cond plate out	15	Sea level
	205	5454	3333	1000	0000	31	Sea level
	206	4444	4344	1121	0100	36	Sea level
	207	4445	3333	0120	0000	32	Sea level
unfair	208	445out	4225	0100	0000	25	Sea level

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Static Blast of 30mm HEI
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APG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
12.	209	5444	4433	0110	0000	33	Sea level
	210	5555	1050	0140	0000	31	60,000 ft.
	211	5454	4454	4001	0000	40	60,000 ft.
	212	5555	5345	0100	0000	38	60,000 ft.
	213	5555	4454	0000	0000	37	60,000 ft.
	214	5555	5444	0001	0000	38	60,000 ft.
	215	5554	5554	0000	0000	38	60,000 ft.
	216	5555	5454	0000	0000	38	60,000 ft.
	217	5555	3454	0000	0000	36	60,000 ft.
	218	5555	4553	0000	0000	37	60,000 ft.
13.	219	4444	3333	1111	0000	32	Sea level
	220	4545	2322	1121	0000	32	Sea level
	221	3454	3332	0121	0000	31	Sea level
	222	4354	4353	0120	0000	34	Sea level
	223	4454	3342	0121	0000	33	Sea level
	224	4454	2232	0010	0000	27	Sea level
	225	4454	4343	1000	0000	32	Sea level
unfair	226	4445	out	1001	0000	19	Sea level
	227	4454	3343	0000	0000	30	Sea level
	228	5454	2332	0000	0000	28	Sea level
	229	5555	5554	1000	0000	40	60,000 ft.
	230	5555	4443	0000	0000	35	60,000 ft.
	231	5555	4554	0000	0000	38	60,000 ft.
	232	5555	5455	0000	0000	39	60,000 ft.
	233	4555	3453	0000	0000	34	60,000 ft.
	234	5555	5444	0000	0000	33	60,000 ft.

APG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
13.	235	5555	4554	0000	0000	38	60,000 ft.
	236	5555	4555	0000	0000	39	60,000 ft.
	237	5555	1001	0001	0000	23	60,000 ft.
	238	5555	4555	0000	0000	39	60,000 ft.
14.	239	2232	1010	0000	0000	11	Sea level
	240	4101	1101	0000	0000	9	Sea level
	241	1100	1001	0000	0000	4	Sea level
	242	2212	0011	0000	0000	12	Sea level
	243	2234	1000	0000	0000	12	Sea level
	244	2233	1121	0000	0000	14	Sea level
	245	2342	1000	0000	0000	12	Sea level
	246	1113	1010	0000	0000	7	Sea level
	247	2232	1010	0010	0000	12	Sea level
	248	2233	1101	0000	0000	13	Sea level
	249	4555	3454	0000	0000	25	60,000 ft.
	250	3354	4555	0000	0000	34	60,000 ft.
	251	3455	2150	0000	0000	24	60,000 ft.
	252	5544	0000	0000	0000	18	60,000 ft.
	253	4555	2252	0000	0000	30	60,000 ft.
	254	4454	4454	0000	0000	24	60,000 ft.
	255	4555	2252	0000	0000	30	60,000 ft.
	256	4455	0000	0000	0000	18	60,000 ft
	257	5454	0000	0000	0000	18	60,000 ft.
	258	4454	0000	0000	0000	18	60,000 ft.
15.	259	4232	1101	0000	0000	14	Sea level
	260	2113	1000	0000	0000	8	Sea level

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APG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
15.	261	2101	1010	0000	0000	6	Sea level
	262	1030	0011	0000	0000	6	Sea level
	263	1100	0011	0000	0000	4	Sea level
	264	2232	1000	0000	0000	10	Sea level
	265	2232	1001	0000	0000	11	Sea level
	266	1000	0001	0000	0000	2	Sea level
	267	1101	1000	0000	0000	4	Sea level
	268	1011	0100	0000	0000	4	Sea level
	269	0000	0000	0000	0000	0	60,000 ft.
	270	0000	0000	0000	0000	0	60,000 ft.
	271	0000	0000	0000	0000	0	60,000 ft.
	272	2332	0000	0000	0000	10	60,000 ft.
	273	0000	0000	0000	0000	0	60,000 ft.
	274	0000	0000	0000	0000	0	60,000 ft.
	275	3322	0000	0000	0000	10	60,000 ft.
	276	0010	0000	0000	0000	1	60,000 ft.
	277	3323	0000	0000	0000	11	60,000 ft.
	278	0000	0000	0000	0000	0	60,000 ft.

Section 2 - Phase 3

Phase 3

A. Test Ammunition

One hundred fifty (150) Shell, HEI, 30mm, T306E10, w/T263E8 Fuze locally modified for static detonation by M-36 blasting cap and loaded as follows:

Ammunition Data

APG COMP. NO.	BASIC EXPLOSIVE	NOMINAL MIXTURE	LOADING TECHNIQUE	NO. OF ROUNDS
A	RDX	100% RDX	Press	20
B	RDX-AL	90/10 RDX/AL	Press	20
C	RDX-AL	80/20 RDX/AL	Press	20
D	RDX-AL	70/30 RDX/AL	Press	20
E & 12	RDX-AL	65/35 RDX/AL	Press	10
F	RDX-AL	60/40 RDX/AL	Press	30
G	RDX-AL	50/50 RDX/AL	Press	30

Note 1 - All shells were loaded with approximately 520 gr. explosive. All shells were topped with RDX/wax 97/3 pressed 140 gr. and faced to a depth of .510"-.520" from nose of shell.

Note 2 - All rounds equipped with T263E8 Fuzes locally modified for static detonation.

B. Field Test Materiel

1. One hundred fifty (150) sheets aluminum plate (24 ST) .032" x 4' x 4'.
2. One hundred fifty (150) sheets aluminum plate (24 ST) .040" x 4' x 4'.
3. One hundred fifty (150) sheets aluminum plate (24 ST) .064" x 4' x 4'.
4. One hundred fifty (150) sheets aluminum plate (24 ST) .081" x 4' x 4'.
5. One hundred fifty (150) M-36 blasting caps.

C. Field Test Equipment

1. 4' APG Blast Cube.
2. APG Stratosphere Chamber (no thermal control).
3. Detonator, Electric, M36A1.

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Phase 3 Page 2

APG COMP NO.	RD. NO.	BLAST DAMAGE				TOTAL	ALTITUDE
		.032	.040	.064	.081		
B	27	4334	1101	0000	0000	17	Sea level
	28	4433	2001	0000	0000	17	Sea level
	29	3333	1122	1011	0000	21	Sea level
	30	3434	1111	0000	0000	18	Sea level
	31	5555	4455	0000	0000	38	60,000 ft.
	32	5555	4455	0000	0000	38	60,000 ft.
	33	5555	2454	1000	0000	36	60,000 ft.
	34	5555	4544	0000	0000	37	60,000 ft.
	35	5554	5454	0000	0000	37	60,000 ft.
	36	5555	5354	0000	0000	37	60,000 ft.
	37	5555	4545	0000	0000	38	60,000 ft.
	38	4555	3455	0000	0000	36	60,000 ft.
	39	5555	4445	0000	0000	37	60,000 ft.
	40	5555	4444	0000	0000	36	60,000 ft.
C	41	3333	1000	0000	0000	13	Sea level
	42	3333	1111	0000	0000	16	Sea level
	43	2232	1111	0000	0000	13	Sea level
	44	2232	1101	0000	0000	12	Sea level
	45	3222	2010	0000	0000	12	Sea level
	46	3322	1101	0000	0000	13	Sea level
	47	3223	1111	0000	0000	14	Sea level
	48	3113	1001	0000	0000	10	Sea level
	49	4111	1101	0000	0000	10	Sea level
	50	2223	0101	0000	0000	11	Sea level
	51	5555	5555	0000	1000	41	60,000 ft.
	52	5554	5555	0000	0000	37	60,000 ft.

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Test:
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Phase 3

APG COMP NO.	RD. NO.	BLAST DAMAGE				TOTAL	ALTITUDE
		.032	.040	.064	.081		
C	53	5555	4434	0000	0000	35	60,000 ft.
	54	5555	4554	0000	0000	38	60,000 ft.
	55	5555	3345	0000	0000	35	60,000 ft.
	56	5555	4455	0000	0000	38	60,000 ft.
	57	5555	5554	0000	0000	39	60,000 ft.
	58	5555	5543	0000	0000	37	60,000 ft.
	59	5555	5543	0000	0000	37	60,000 ft.
	60	5555	5554	1000	0000	40	60,000 ft.
D	61	4444	2222	0110	0100	27	Sea level
	62	4444	4433	0000	0000	30	Sea level
	63	4444	2222	2211	0000	31	Sea level
	64	4444	2432	2100	1000	31	Sea level
	65	4444	2233	1011	0000	29	Sea level
	66	4454	3333	0000	0000	29	Sea level
	67	4454	4343	0100	0000	32	Sea level
	68	4444	3344	1000	0000	31	Sea level
	69	5555	5544	0000	0000	38	60,000 ft.
	70	5555	5555	0000	0000	40	60,000 ft.
	71	5555	5555	0000	0000	39	60,000 ft.
	72	5555	5444	0000	0000	37	60,000 ft.
	73	5554	4455	1000	0000	38	60,000 ft.
	74	5555	5555	0000	0000	40	60,000 ft.
	75	5554	5554	0000	0000	38	60,000 ft.
	76	5554	5544	0000	0000	37	60,000 ft.
	77	5555	4455	1000	0000	39	60,000 ft.
	78	5554	5544	0000	0000	37	60,000 ft.

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Static Blast of 30mm HEI Explosive Fillers
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APG CONF NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
E and 12	79	5555	5444	1000	0000	38	60,000 ft.
	80	5555	5555	1110	0000	43	60,000 ft.
	81	5554	5554	0000	0000	38	60,000 ft.
	82	5555	5554	0000	0000	39	60,000 ft.
	83	5555	5555	0000	0000	40	60,000 ft.
	84	5544	5554	2100	0000	40	60,000 ft.
	85	5555	5555	1000	1000	42	60,000 ft.
	86	5554	5444	0000	0000	36	60,000 ft.
	87	5554	5444	0000	0000	36	60,000 ft.
	88	5554	5554	1000	1000	40	60,000 ft.
F	89	5544	4333	2100	1000	35	Sea level
	90	5444	4444	2100	0000	36	Sea level
	91	5544	4334	1110	0000	36	Sea level
	92	5443	4433	2111	1000	36	Sea level
	93	5444	4433	2110	0000	35	Sea level
	94	5444	4443	1111	1000	37	Sea level
	95	5444	4423	2100	1000	35	Sea level
	96	5544	5433	1110	1100	38	Sea level
	97	5544	4444	1100	0000	35	Sea level
	98	5544	4433	1111	1000	37	Sea level
	99	5455	5444	0000	0000	36	60,000 ft.
	100	5555	4433	0000	0000	34	60,000 ft.
	101	5455	5544	0000	0000	37	60,000 ft.
	102	5555	5443	0000	0000	36	60,000 ft.
	103	5555	5544	0000	0000	38	60,000 ft.
	104	5555	5544	0000	0000	38	60,000 ft.

For Comp E firing at Sea level, see Phase 1, Comp 12

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Test of:
Static Blast of 30mm HEI Explosive Fillers

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APG COMP NO.	RD. NO.	BLAST DAMAGE .032	.040	.064	.081	TOTAL	ALTITUDE
F	105	5555	5444	0000	0000	37	60,000 ft.
	106	5554	5444	0000	0000	36	60,000 ft.
	107	5554	4555	0000	0000	38	60,000 ft.
	108	5555	5444	0000	0000	37	60,000 ft.
	109	5555	5444	0000	0000	37	60,000 ft.
	110	5554	5444	0000	0000	36	60,000 ft.
	111	5555	4444	0000	0000	36	60,000 ft.
	112	5555	4443	0000	0000	35	60,000 ft.
	113	5555	3311	0000	0000	28	60,000 ft.
	114	5554	5444	0000	0000	36	60,000 ft.
	115	5555	4444	0000	0000	36	60,000 ft.
	116	5555	5543	0000	0000	37	60,000 ft.
	117	6554	4443	0000	0000	34	60,000 ft.
	118	5555	5443	0000	0000	36	60,000 ft.
G	119	5444	4433	2111	0000	36	Sea level
	120	5444	4444	1110	0000	36	Sea level
	121	5444	4433	1111	1000	36	Sea level
	122	4444	4443	1100	0000	33	Sea level
	123	5444	4433	2100	1100	36	Sea level
	124	5444	4333	1100	0000	32	Sea level
	125	5444	4444	1100	0000	35	Sea level
	126	4444	5444	1100	0000	35	Sea level
	127	5444	4433	1100	1100	35	Sea level
	128	5444	4333	1110	1000	34	Sea level
	129	5554	4433	0000	0000	33	60,000 ft.
	130	5554	4443	0000	0000	34	60,000 ft.

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APG COMP NO.	RD. NO.	BLAST DAMAGE				TOTAL	ALTITUDE
		.032	.040	.064	.081		
G	131	5554	5110	0000	0000	26	60,000 ft.
	132	5555	5432	0000	0000	34	60,000 ft.
	133	5555	5444	0000	0000	37	60,000 ft.
	134	5554	5544	2100	0000	40	60,000 ft.
	135	5554	5554	2100	0000	41	60,000 ft.
	136	5544	5544	0000	0000	36	60,000 ft.
	137	5554	5544	2110	0000	41	60,000 ft.
	138	5554	5554	4100	0000	43	60,000 ft.
	139	5555	5444	2200	0000	41	60,000 ft.
	140	5554	5544	0000	0000	37	60,000 ft.
	141	5555	5544	0000	0000	38	60,000 ft.
	142	5555	5544	2221	0000	45	60,000 ft.
	143	5554	5544	0000	0000	37	60,000 ft.
	144	5555	5554	0000	0000	39	60,000 ft.
	145	5555	5554	2100	0000	42	60,000 ft.
	146	5555	5554	0000	1000	40	60,000 ft.
	147	5544	5444	0000	0000	35	60,000 ft.
	148	5555	1000	3210	0000	27	60,000 ft.

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Section 3 - Phase 4

Phase 1

A. Ammunition Data

Eight (8) Shell, 30mm, T306E10 w/T26E3 Fuze locally modified for static detonation by M-36 blasting cap and loaded with approximately 520 gr. MOX-2B (press loaded) w/140 gr. 97/3 RDX/wax topoff faced to a depth of .510"-.520" from nose of shell.

B. Field Test Material

1. Eight (8) sheets aluminum plate (24 ST) .032" x 4' x 4'.
2. Eight (8) sheets aluminum plate (24 ST) .040" x 4' x 4'.
3. Eight (8) sheets aluminum plate (24 ST) .064" x 4' x 4'.
4. Four (4) sheets aluminum plate (24 ST) .081" x 4' x 4'.
5. Eight (8) M-36 blasting caps.

C. Field Test Equipment

1. 4' APG Blast Cube.
2. APG Stratosphere Chamber (no thermal control).
3. Detonator, Electric, M36A1.

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Static Blast of 30mm HEI Explosive Fillers

Phase 4 Page 1

APG COMP NO.	RD. NO.	BLAST DAMAGE				TOTAL	ALTITUDE
		.032	.040	.064	.081		
H.	1	4444	4333	1111	0000	33	Sea level
	2	4443	5444	1000	0000	33	Sea level
	3	5555	5543	0000	0000	37	60,000 ft.
	4	5554	5544	0000	0000	37	60,000 ft.
	5	2233	2211	1000	out	17	Sea level
	6	2222	1113	1000	out	15	Sea level
	7	3112	1100	0000	out	9	60,000 ft.
	8	1112	1100	0000	out	7	60,000 ft.

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APPENDIX C

Method of Computation of Results

COMPUTATION OF RESULTS

All rounds fired in the Blast Cube under a given set of conditions, i.e. explosive filler and altitude, were averaged. A deviation from this average for each round was determined by addition and subtraction. The arithmetic sum of these deviations was taken and an average deviation determined. An allowable spread of three times the average deviation was employed wherein scores of all rounds beyond this spread were discarded on the assumption that scores beyond this region could not normally be expected under the given conditions, and that their probability of occurrence was in the neighborhood of one in ten thousand.

Example:

APG Comp. #5 detonated at sea level.

Scores -	Deviations -
29	0 (29-29)
29	0 (29-29)
27	2 (29-27)
25	4 (29-25)
29	0 (29-29)
31	2 (31-29)
29	0 (29-29)
37	8 (37-29)
26	3 (29-26)
32	3 (32-29)
294	22

Average: 294 ÷ 10 = 29.4 or 29 Average Deviation: 22 ÷ 10 = 2.2

Three times Average Deviation: 3 x 2.2 = 6.6 = Allowable Spread

Therefore, the value 37 is thrown out as this exceeds the allowable spread of 6.6, meaning the probability of this score occurring under the given conditions is extremely small and cannot be expected.

COMPUTATION OF RESULTS (CONTD)

A new average and spread is now computed omitting the value 37.

Scores -		Deviations -	
	29	0	(29-29)
	29	0	(29-29)
	27	2	(29-27)
	25	4	(29-25)
	29	0	(29-29)
	31	2	(31-29)
	29	0	(29-29)
	26	3	(29-26)
	32	3	(32-29)
	257	14	

Average: 257 ÷ 9 = 28.6 or 29 Average Deviation: 14 ÷ 9 = 1.555

Three times Average Deviation: 3 x 1.555 - 4.65 or 4.7

All of the remaining scores lie within 4.7 of the average. Thus 4.7 becomes the Allowable Spread.

APPENDIX D

Summarized Test Results

Section 1 - Phase 1
Section 2 - Phase 3
Section 3 - Phase 4

Section 1 - Phase 1

TABULATION OF RESULTS - Phase 1

COMP NO.*	ALTITUDE	FAIR ROUNDS ALLOWED	FAIR ROUNDS DISALLOWED	AVERAGE SCORE	AVERAGE DEVIATION	ALLOWABLE SPREAD	UNFAIR ROUNDS
1	Sea level	10	0	20.0	2.6	7.8	0
	60,000	6	0	24.0	3.67	11	4
2	Sea level	10	0	10.9	7.3	21.9	0
	60,000	10	0	23.2	4.2	12.6	0
3	Sea level	10	0	8.3	2.5	7.5	0
	60,000	9	1	19.7	1.0	3.0	0
4	Sea level	12	0	25.6	1.92	5.75	0
	60,000	7	0	32.2	6.15	18.45	0
5	Sea level	9	1	28.6	1.56	4.7	0
	60,000	10	0	33.9	4.7	14.1	0
6	Sea level	10	0	29.0	2.4	7.2	0
	60,000	8	1	36.4	1.375	4.13	0
7	Sea level	10	0	28.9	1.1	3.3	0
	60,000	10	0	34.8	1.8	5.4	0
8	Sea level	10	0	10.7	2.5	7.5	0
	60,000	8	1	20.1	1.125	3.38	1
10	Sea level	10	0	29.9	3.3	9.9	0
	60,000	9	1	36.6	.89	2.67	0
11	Sea level	8	0	31.2	1.75	5.25	0
	60,000	12	0	37.2	1.5	4.5	0
12	Sea level	9	0	32.9	1.89	5.67	2
	60,000	8	1	37.8	.75	2.25	0
13	Sea level	9	0	31.0	1.78	5.33	1
	60,000	9	1	37.3	2.22	6.66	0
14	Sea level	9	1	10.6	1.67	5.0	0
	60,000	10	0	25.9	6.7	20.1	0
15	Sea level	10	0	6.4	3.0	9.0	0
	60,000	10	0	3.2	4.2	12.6	0

* See Appendix B

Section 2 - Phase 3

TABULATION OF RESULTS - Phase 3

COMP NO.*	ALTITUDE	FAIR ROUNDS ALLOWED	FAIR ROUNDS DISALLOWED	AVERAGE SCORE	AVERAGE DEVIATION	ALLOWABLE SPREAD	UNFAIR ROUNDS
A	Sea level	10	0	10.8	1.6	4.8	0
	60,000	10	0	22.9	4.1	12.3	0
B	Sea level	10	0	20.2	1.8	5.4	0
	60,000	10	0	37.0	.60	1.8	0
C	Sea level	10	0	12.4	1.4	4.2	0
	60,000	10	0	37.7	1.5	4.5	0
D	Sea level	10	0	28.7	1.3	3.9	0
	60,000	10	0	38.3	.90	2.7	0
E & 12	Sea level	10	0	32.9	1.89	5.67	0
	60,000	10	0	39.2	1.8	5.4	0
F	Sea level	10	0	36.0	.80	2.4	0
	60,000	19	1	36.3	.84	2.53	0
G	Sea level	10	0	34.8	1.0	3.0	0
	60,000	20	0	37.3	3.7	11.1	0

* See Appendix B

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Section 3 - Phase 4

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TABULATION OF RESULTS - Phase 4

COMP NO.*	ALTITUDE	FAIR ROUNDS ALLOWED	FAIR ROUNDS DISALLOWED	AVERAGE SCORE
With all sides of Blast Cube in place.				
H	Sea level	2	0	33
	60,000 ft.	2	0	37
** With .081" side omitted.				
	Sea level	2	0	16
	60,000 ft.	2	0	8

* See Appendix B.

** In all firings, with four sides in place on cube, the .081" aluminum plate received little or no damage.

APPENDIX E

Blast Cube Procedure and Analysis

Section 1

Blast Cube Set-up and Scoring

DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND, MARYLAND

STANDARD STATIC TEST FOR RELATIVE BLAST EFFECTIVENESS OF 27MM & 30MM SHELL FOR COMPARISON OF VARIOUS EXPLOSIVE FILLERS

I OBJECT

The blast test is designed to compare explosive fillers for 27mm and 30mm shell by determining blast damage resulting from detonation in the APG 48" test cube.

II DESCRIPTION OF TEST CUBE (See Dwg No. 2, Appendix G)

A. The 48" test cube consists of 2-1/2" thick steel plates at top and bottom joined by four 3" square columns welded to the corresponding corner of each plate. A 1-1/2" dia hole is drilled through the geometric center of the top plate. Fifty 3/8" studs are spaced equidistant around the edges of each side of the cube. Aluminum Alloy plates, with holes drilled to fit the studs, are attached to the four sides of the cube. Steel bars which also have holes drilled to fit over the studs are placed on the edges of the cube sandwiching the side plates between it and the edges of the steel plates or columns. The bars are serrated on dural plate contact side to prevent plates from tearing out of their edge support. The bars are secured to the cube by nuts, tightened with a torque wrench to prevent stud breakage. A torque of 250 inch lbs is generally sufficient.

B. The aluminum 24ST alloy side plates used are .032", .040", .064" and .081" thick, one thickness on each side of the cube. The plates are weakened in a like manner by cuts starting in each corner and extending diagonally to within 9" of plate center. A 1/4" hole is drilled at the extremity of each cut to relieve stress concentrations at these points.

III AMMUNITION

A. Shell, HEI, 30mm, T306E10

B. Fuze, PD, T263E8 modified for static initiation by Detonator, Electric, No. M36.

The fuze is modified for use with the electric detonator by drilling a hole through the tip of the nose cover and by removing the firing pin and detonator holder. The electric detonator is then inserted through the hole in the tip of the fuze after the fuze is attached to the shell and fastened by any type of adhesive tape after making sure detonator is in contact with booster explosive.

STANDARD STATIC TEST FOR RELATIVE BLAST EFFECTIVENESS OF 27MM & 30MM SHELL FOR COMPARISON OF VARIOUS EXPLOSIVE FILLERS

IV PROCEDURE

A. The shell, with detonator attached, is inserted through the hole in the top plate to the geometric center of the cube, shell axis remaining vertical, fuze end up. The charge is statically detonated in that position.

B. A minimum of 5 samples of each filler under test will be detonated. When more than one filler is being tested, single rounds of each filler will be detonated alternately throughout the test to minimize any effect from changes in test conditions on average results.

C. The damage to the sides of the cube is evaluated and numerically recorded using the following method. In any case where a panel tears loose from the studs the results will be disregarded & a substitute rd. detonated.

1. The maximum damage evaluation for the 4 sides of the cube is 80.

2. The maximum damage evaluation for each side is 20.

3. The maximum damage evaluation for each panel section on a side is 5.

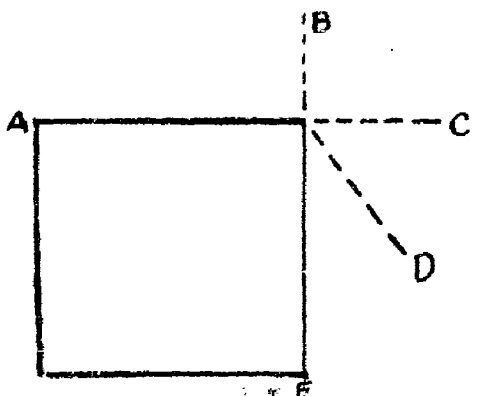
4. The panel section blown out to a position (from B to A on sketch) 180° - 270° from original position is evaluated as 5.

5. A panel section blown out to a position 90° - 180° from original position (C to B) is evaluated as 4.

6. A panel section blown out to a position 45° to 90° from original position (D to C) is evaluated as 3.

7. A panel section severed from the other panels but blown out less than 45° from original position (E to D) is evaluated as 2.

8. A panel section having a crack of 1" or more is evaluated as 1.



STANDARD STATIC TEST FOR RELATIVE BLAST EFFECTIVENESS OF 27MM & 30MM SHELL FOR COMPARISON OF VARIOUS EXPLOSIVE FILLERS

V DATA TO BE RECORDED

Following is a list of data to be recorded with the suggested form.

Shell Nomenclature & Lot No. Detonator Nomenclature & Lot No.
Fuze Nomenclature & Lot No.

Rd. No.	Type Filler	Weight of Filler	Numerical Damage Evaluation: .032" Panels 1 2 3 4 Total	.040" Panels 1 2 3 4 Total	.064" Panels 1 2 3 4 Total	.081" Panels 1 2 3 4 Total	Total
(1)	(2)	(3)		(4)			

(1) Test round number

(2) Identification of explosive filler

(3) The actual total weight of explosive filler contained in shell body. When a top off of different explosive or a composite filler is used such should be noted at bottom of data sheet.

(4) The numerical damage evaluation for each panel of each side, total for each side and total for all four sides.

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Section 2

Suggested Revision of Blast Cube Scoring System

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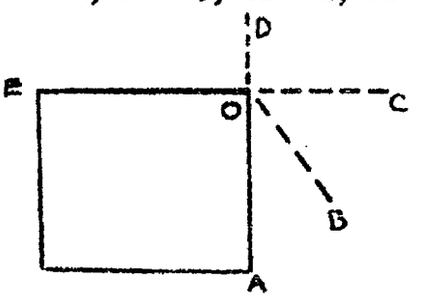
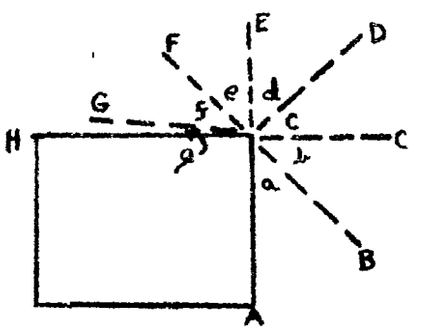
A. Suggested Revision of Blast Cube Scoring System

1. In many instances during the firing of this test, it was felt that the present blast cube scoring system did not give a fair comparison between rounds. The current scoring outlined in the previous section gives a value of one (1) for any plate segment with a crack of 1" or more. Segment displacements as shown here give scores of AB = 2, BC = 3, CD = 4, DE = 5:



2. It was observed that many rounds did no more than cause 1" or 2" cracks in a given plate segment, while other rounds caused extensive rips and tears without any displacement of the segment; yet the present system assigns identical scores. Also, many rounds would displace a segment to a position just within the DE or 5 area, while other rounds with obviously greater blast effect would actually "plaster" the segment along the EO line destroying the plate's ability to spring back or "breaking its back" so-to-speak. In spite of this obvious difference in blast strength, the project engineer would be constrained to score both rounds as if they possessed equivalent blast strength. With this in mind, it is suggested that the scoring system be modified as follows:



$\angle$s a, b, c, d, e, f = 45° $\angle$g = 20°
AB = 4 BC = 5 CD = 6 DE = 7 EF = 8 FG = 9 GH = 10

Segment with cracks, rips, and tears but not displaced to be scored 1, 2, or 3 according to the severity of blast crack damage. It is felt that this suggestion if followed will give more uniform scores and provide for sharper discrimination between the relative blast effectiveness of various explosive mixtures.

Section 3

Blast Cube Analysis

A. Blast Cube Analysis

1. Lack of correlation between the results of previous tests in aircraft structures and blast cubes was demonstrated in Phases 1-3.

Rounds fired in the blast cube show an increase in effectiveness with increasing altitude, while rounds detonated in aircraft structures show a decrease in effectiveness with increasing altitude (See Firing Record P-60189 Project TB3-0226A - Blast Effect of Bare Charges on Aircraft Structures at Various Low Pressures Simulating High Altitudes).

2. It was suggested that the reason for this conflict might be in the fact that an aircraft structure is never a completely closed system, whereas the blast cube does constitute essentially a closed system. It was predicted that blast cube firing with one side of the cube removed for venting purposes, would give decreasing scores with increasing altitude. In Phase 4, this prediction was tested and confirmed.

3. The following argument is submitted as a possible explanation of this phenomenon. At sea level in the blast cube, part of the force of the explosion is dissipated as heat in setting the surrounding atmosphere in motion. When the blast wave and expanding explosion products reach the side of the cube, not only must the resistance of the aluminum sheet be overcome, but the pressure of the air outside the cube as well. In a vacuum the expanding explosion products reach the cube boundaries with perfect efficiency since no atmosphere is present to hinder the action. In addition, the walls lack the added support of the surrounding atmosphere. As a consequence, as altitude increases and a vacuum is approached, increasing blast damage may be expected.

4. The argument applies only when the cube is completely enclosed and the explosive force must pass through the cube walls. If one wall is omitted, a significant amount of the explosive force will be vented through this opening. As a result, the peak pressure against the walls (a combination of explosive products, blast wave, and reenforcement of the blast wave by reflection from opposite and adjacent walls) will be considerably lower and, of course, cannot be maintained for any significant length of time. If this opening is restricted in any manner the venting will be reduced with resultant intensification of both the strength and duration of peak pressure, causing greater damage. A subtle but hardly negligible way of restricting this vent would be by the presence of air. At sea level, the air serves to confine the explosive force causing a slightly higher peak pressure and maintaining this peak for a brief period. At simulated high altitudes, the lack of air increases the venting effect, thereby decreasing blast damage. From results obtained in Phase 4, it must be concluded that the increased venting effect at high altitudes, overrides the tendency toward higher scores caused by lessened resistance of atmosphere surrounding the cube walls.

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5. As previously stated, the foregoing is offered as a rational explanation for observed phenomena. Since little is known about true cause and effect here, it is entirely possible that this argument only partly explains the facts. With this in mind, it is suggested that a program be instituted to determine the reason for this behavior through various instrumented tests. It is believed that with information gained from such tests, scoring and design modifications in the blast cube and blast cube procedure, could be incorporated, thus rendering the blast cube a reliable and valuable tool in the prediction of blast results in aircraft type structures.

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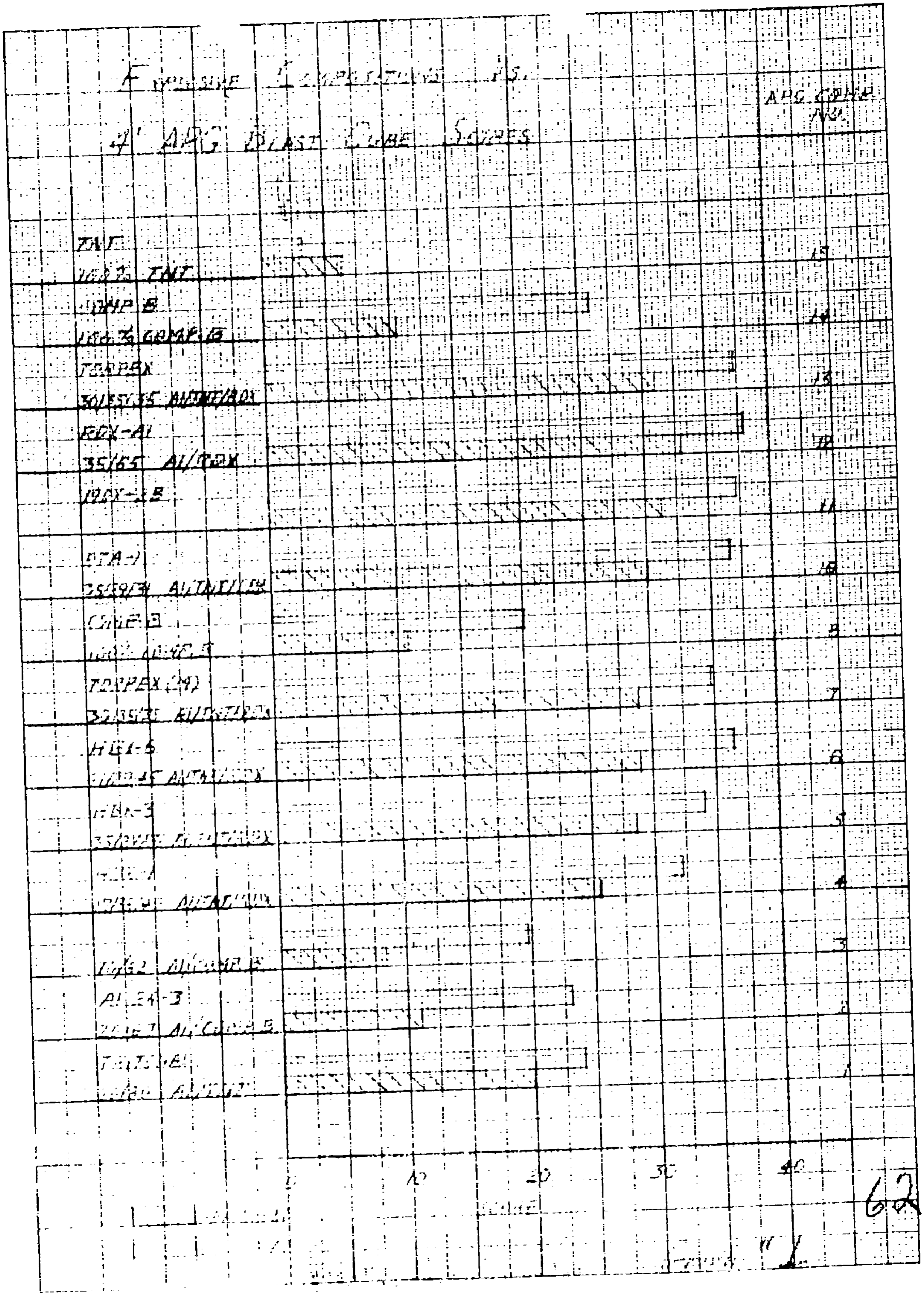
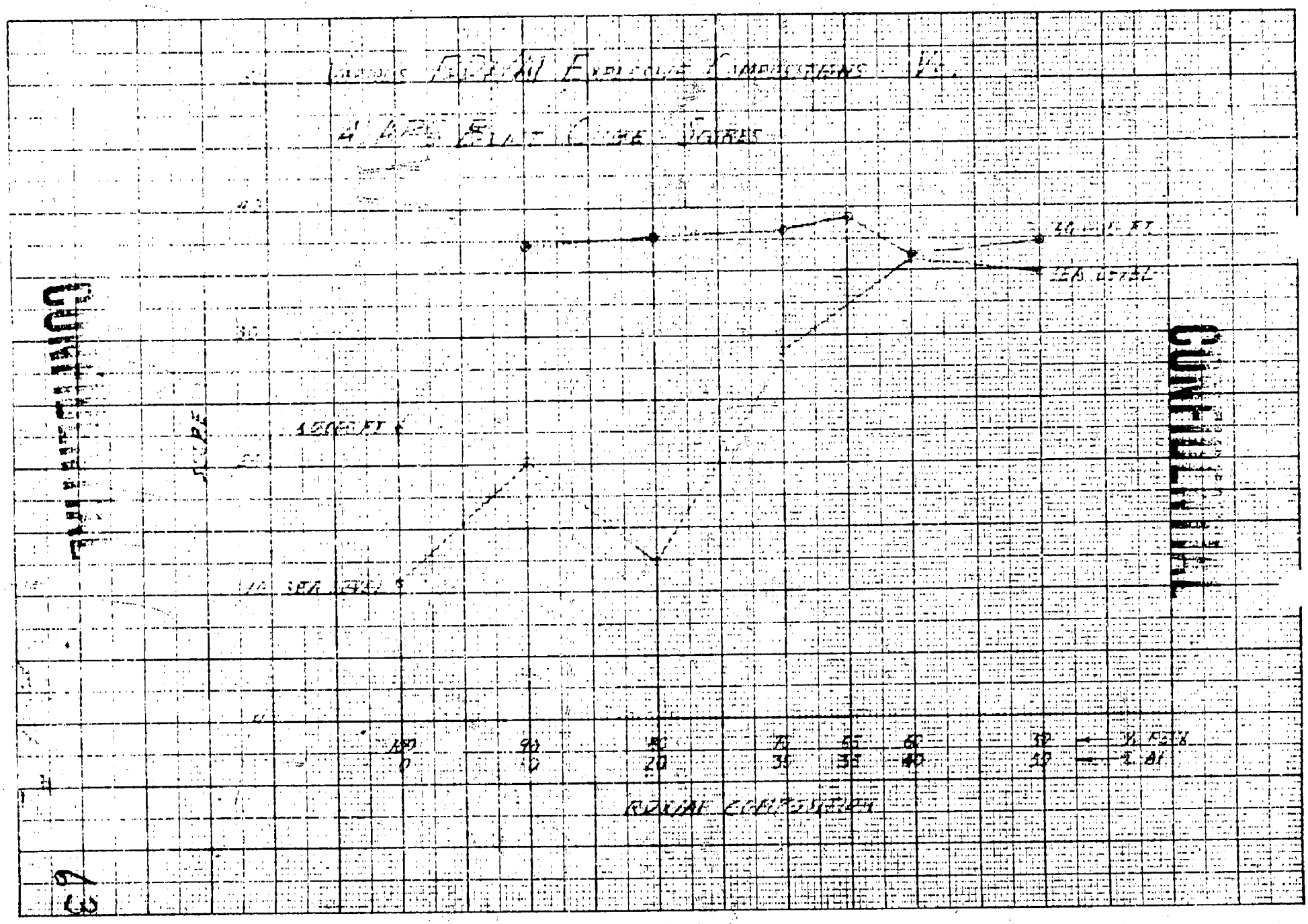
APPENDIX F

Graphs

1. Comparison of Results (Phase 1)
2. Effect of Altitude on Blast (Phase 3)
3. Effect of Blast Cube Modification on Blast (Phase 4)


4' APG BLAST CUBE SCORES
APG GRPH NO.
TNT
COMP B
TORPEX
30/35/35 AL/TNT/RDX
RDX-AL
35/65 AL/RDX
ETA-1
COMP B
TORPEX (29)
HBX-3
AL 24-3
0
10
20
30
40

62


SEA LEVEL
SEA LEVEL
RADIAL DISTANCE

EFFECT ON BLAST GAUGE SCALES CREATED BY REMOVAL OF ONE SIDE OF CUBE

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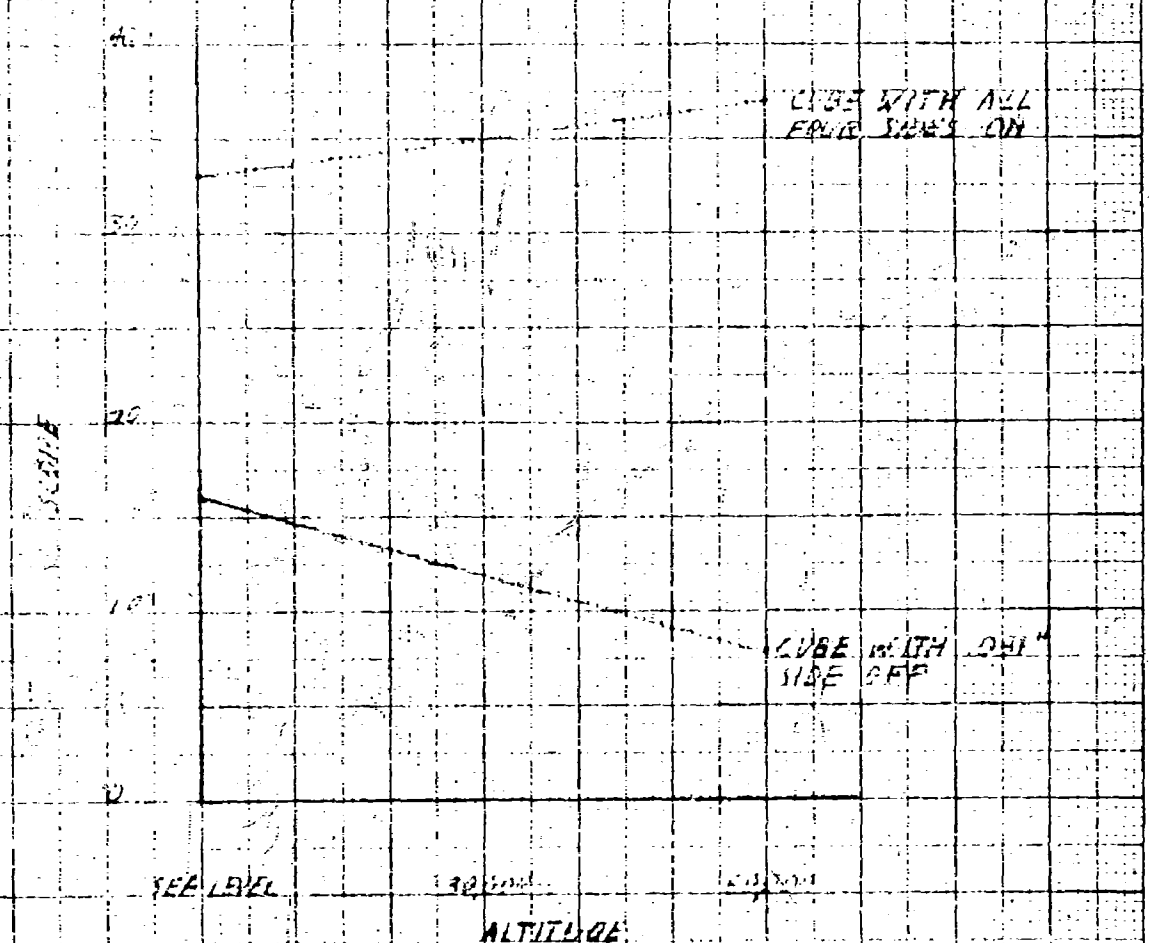

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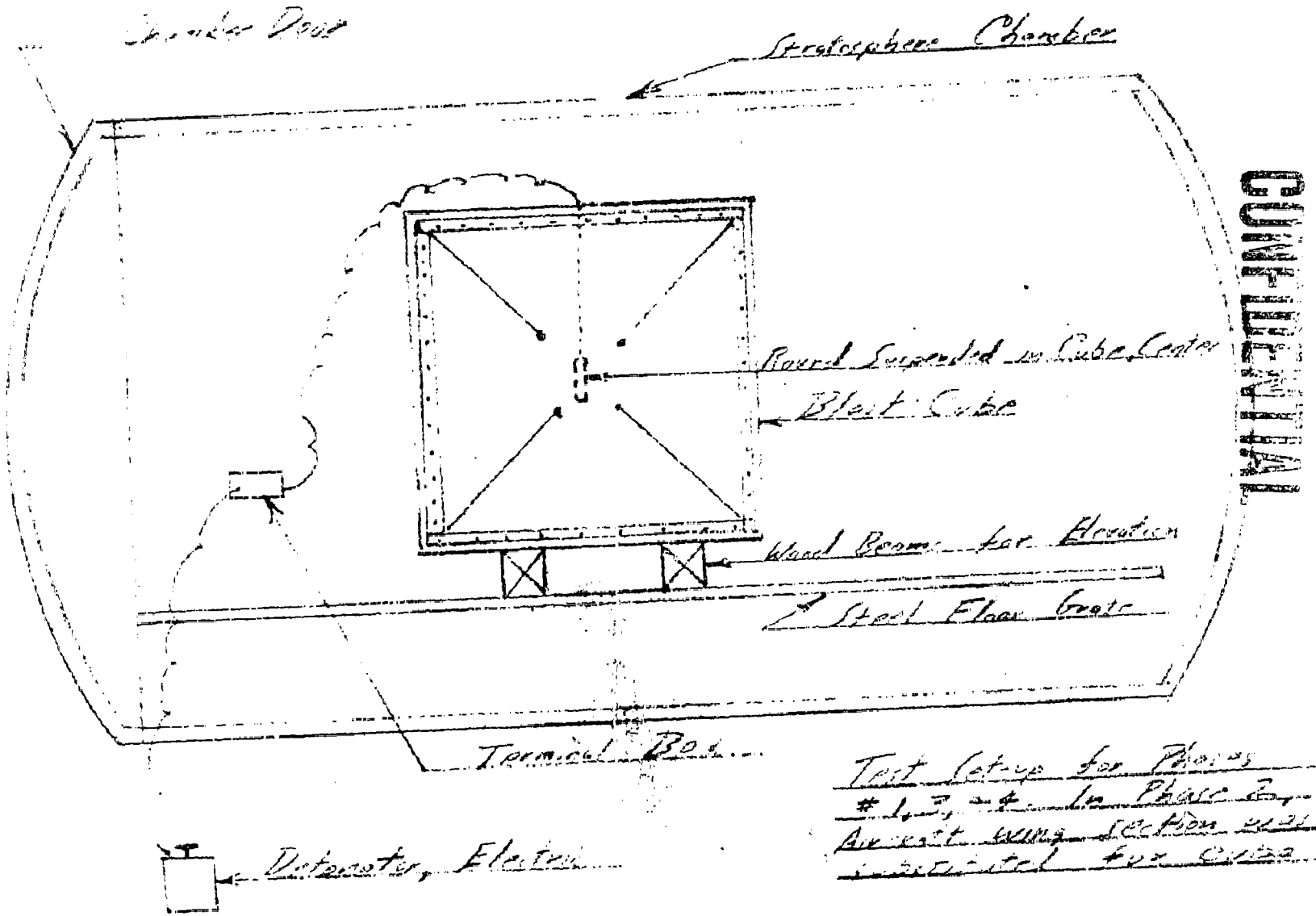
APPENDIX B

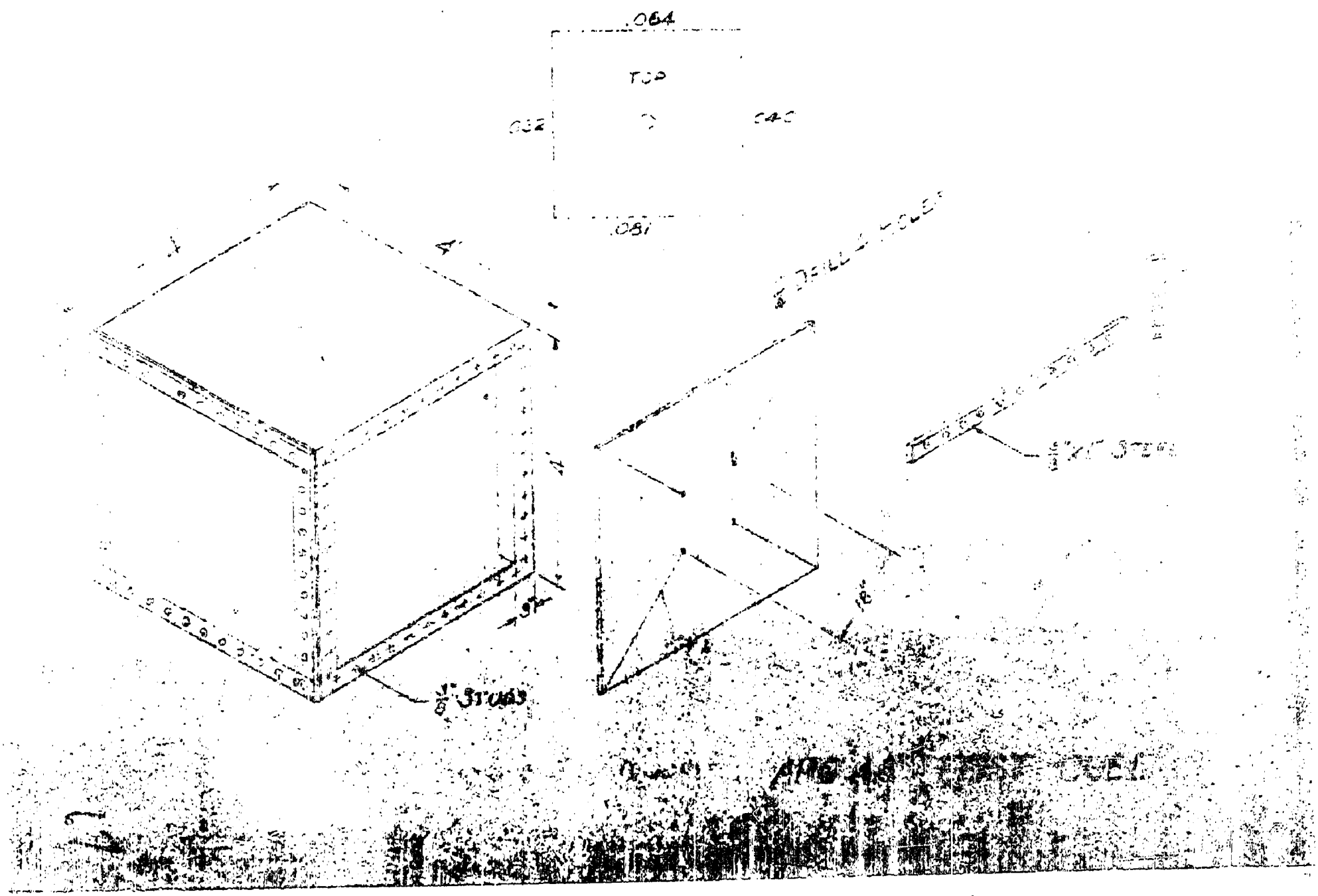
Drawings

1. Test Set-up
2. Blast Cube Sketch



Test Set-up for Plans #1, 2, & 3 to Place in Aircraft Wing Section and Interior for Cube

RELATIVE POSITION OF 24 S-T PLATE



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APPENDIX H

Air Force Assessment Sheets

(Phase 2)

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

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ROUND NUMBER: One

DATE: 1 February 1955

ASSESSORS: M/Sgt. A. W. HAMMER, M/Sgt. C. T. Bove

SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside right wing, 12" aft of rear spar, midway between top and bottom skin at Station 741.

SIMULATED ALTITUDE: Sea level

BLAST: Destroyed right wing of trailing edge, top and bottom skin, and ribs between Wing Stations 711 and 747. Tore loose trailing edge, top and bottom skin between Stations 747 and 761. Ballooned (one inch maximum) tail ribs at Stations 747 and 751. Structural and/or projectile fragments cut two 1/2- by 3/4-inch holes, three 1/2-inch-diameter holes and five holes of less than 1/2-inch diameter in tail rib at Station 747. Also cut a 1/2-inch-square hole and a 1/4- by 1/2-inch hole and two 1/4-inch-diameter holes in rear spar web.

NOTE: Aileron was not installed

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ROUND: Number Two

DATE: 1 February 1955

ASSESSORS: M/Sgt. A. W. Hammer, M/Sgt. C. T. Bove

SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside right wing, 12" aft of rear spar, and midway between top and bottom skin at Station 800.

SIMULATED ALTITUDE: Sea level

BLAST: Destroyed right wing trailing edge top and bottom skin and tail ribs between Wing Stations 795 and 819. Ballooned (one inch maximum) wing trailing edge ribs at Stations 819, 795, 780 and 790. Tore loose and peeled back wing trailing edge, top and bottom skin, between Stations 771 and 795. Lightly ballooned (one-half inch maximum) rear spar web between Stations 795 and 819. Structural and/or projectile fragments: cut a 1/2-inch-diameter hole, a 1/4-inch-diameter hole, and three holes of less than 1/4-inch diameter in rear spar web; cut a 3/4-inch square hole, a 1/2- by 3/4-inch hole, four 1/2-inch-diameter holes and four holes of less than 1/2-inch diameter in tail rib at Station 819; and cut a 3/4-inch-diameter hole, three 1/2-inch-diameter holes, three 1/4-inch-diameter holes, a 1/4- by 1-inch hole, and a 1/4- by 1/2-inch hole in tail rib at Station 795.

NOTE: Aileron was not installed

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STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

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ROUND NUMBER: Three

DATE: 1 February 1955

ASSESSORS: M/Sgt. A. W. Hammer, M/Sgt. C. T. Bove

SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside right wing midway between front and rear spars and two inches inboard of Wing Station 747.

SIMULATED ALTITUDE: Sea Level

BLAST: Ballooned (four inches maximum) right wing inter-spar bottom skin and structure between Wing Stations 699 and 771, tore loose and ballooned (three inches maximum) inter-spar ribs at Station 723 and 747. Structural and/or projectile fragments: cut a three-inch-triangular hole, two 1- by 2-inch holes, three 1-inch square holes, nine 1/2-inch-diameter holes, and five holes of less than 1/2-inch diameter in wing top skin; cut four 1/2- by 1-inch holes, six 1/2-inch-diameter holes and six holes of less than 1/2-inch diameter in inter-spar ribs at Stations 723 and 747; cut a ragged two- by six-inch hole, a one- by two-inch hole, two 1/2- by 1-inch holes, four 1/2-inch-diameter holes and ten holes of less than 1/2-inch diameter in wing bottom skin, severing two stringers and fifty per cent severing one additional stringer; cut two 1/2-inch diameter holes in rear spar web; and cut two 1/4-inch-diameter holes and three holes of less than 1/4-inch diameter in front spar web.

NOTE: Damage from this round was combined with damage from Round 4.

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

ROUND NUMBER: Four SIMULATED ALTITUDE: Sea level

DATE: 1 February 1955

ASSESSORS: M/Sgt. A. W. Hammer, M/Sgt. C. T. Bove

SHELL TYPE: 20mm, HEI, T202E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside right wing, midway between front and rear spars, and six inches inboard of Wing Station 795.

BLAST: Lightly ballooned (1/2-inch maximum) right wing inter-spar, top skin and structures, between Wing Stations 747 and 819, popping loose approximately thirty rivets attaching skin to stringer; ballooned (four inches maximum) right wing inter-spar bottom skin and structures, severing two stringers, between Stations 747 and 819; fifty per cent severed and tore loose inter-spar rib at Station 795; tore loose and ballooned (two inches maximum) inter-spar ribs at Stations 771 and 819. Structural and/or projectile fragments cut a ragged 1½- by 6-inch hole, a one-inch-diameter hole, a one-inch triangular hole, a one-inch-square hole, two 1/4- by 1-inch holes, two 1/2-inch-diameter holes, and twelve holes of less than 1/4-inch diameter in wing bottom skin; cut two 1/2-inch-diameter holes and six holes of less than 1/2-inch diameter in rear spar web; cut a one-inch triangular hole, two 1/2-inch-diameter holes, and three holes of less than 1/2-inch diameter in inter-spar ribs at Stations 819 and 795; cut a 1/2-inch-diameter hole and three holes of less than 1/2-inch diameter in front spar web.

NOTE: Damage from this round was compounded with damage from Round 3.

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

CONFIDENTIAL

ROUND NUMBER: Five SIMULATED ALTITUDE: Sea level

DATE: 1 February 1955

ASSESSORS: M/Sgt. A. W. Bonnor, M/Sgt. C. T. Bovo

SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside right wing tip, midway between front and rear spars, and five inches outboard of Wing Station 831.

BLAST: Partially destroyed, tore loose, and peeled back right wing tip, top and bottom inter-spar skin, between Wing Stations 819 and 842; partially destroyed and severed inter-spar rib at Station 831; fifty per cent severed and ballooned (three inches maximum) inter-spar rib at Station 842; severed and tore loose inter-spar rib at Station 819; severed wing tip, front spar, six inches outboard of Stations 819; ballooned (one inch maximum) wing tip, top and bottom skin, from rear spar to 24 inches aft of same, and between Stations 819 and 850; popped loose and ballooned (two inches maximum) wing tip, top and bottom skin, and structures, from leading edge to twenty-four inches aft of rear spar and between Stations 842 and 850; ballooned wing tip, rear spar web, between Stations 819 and 842. Structural and/or projectile fragments cut a three-inch-square hole, two 1½- by 1-inch holes, three 1-inch-square holes, three 1/2-inch-diameter holes and ten holes of less than 1/2 inch diameter in wing tip, top and bottom skin, between Stations 842 and 850; cut four holes of less than 1/2-inch diameter in wing tip, rear spar.

NOTE: Aileron was not installed.

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

ROUND NUMBER: Six

DATE: 10 February 1955

ASSESSOR: M/Sgt. A. W. Hammer

SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside left wing, ten inches outboard of Wing Station 723 and midway between front and rear spars.

SIMULATED ALTITUDE: 60,000 Feet

BLAST: Ballooned (three inches maximum) left wing inter-spar, bottom skin and structures, severed one stringer between Wing Stations 699 and 747, buckled (three inches maximum) and tore loose inter-spar ribs at Stations 723 and 735. Projectile fragments cut two 1/2 by 3/4-inch holes, a 1/2-inch-diameter hole and two 1/4-inch-diameter holes in rear spar web; cut three 1/2- by 1-inch holes, two 1/2-inch-square holes, a 1/2-inch triangular hole and twelve holes of less than 1/2-inch diameter in inter-spar ribs at Stations 723 and 735; cut two 1/4-inch-diameter holes in front spar web; cut a one-inch-square hole, two 1-inch triangular holes, two 1/2- by 3/4-inch holes, two 1/2-inch-diameter holes, three 3/8-inch-diameter holes; and seven 1/4-inch-diameter holes in wing inter-spar, top skin; cut a one- by two-inch hole, a 3/4- by 1-inch hole, a 1/4- by 1/2-inch hole, six 1/2-inch-diameter holes, and approximately twenty holes of less than 1/2-inch-diameter in wing inter-spar bottom skin.

NOTE: Damage from this round compounded with damage from Round Seven.

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

[redacted]

ROUND NUMBER: Seven

DATE: 10 February 1955

ASSESSOR: M/Sgt. A. W. Hammer

SHELL TYPE: 20mm, HEI, T202E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside left wing, midway between front and rear spars, and six inches outboard of Wing Station 771.

SIMULATED ALTITUDE: Sixty Thousand Feet

BLAST: Ballooned (three inches maximum) left wing inter-spar bottom skin and structures, between Wing Stations 735 and 819; lightly ballooned (1/4-inch maximum) wing inter-spar, top skin, between Stations 735 and 795, popping loose three rivets attaching top skin to rib; buckled (two inches maximum) and tore loose inter-spar ribs at Stations 771 and 795. Projectile fragments seventy-five per cent severed one wing top skin stringer; seventy-five per cent severed one wing bottom skin stringer; cut a two-inch-square hole, a 1- by 2-inch hole, a one-inch square hole, a 3/4- by 1-inch hole, two 3/4-inch-square holes, a 3/8- by 1-inch hole, three 1/2-inch-diameter holes and twenty holes of less than 1/2-inch diameter in wing inter-spar top skin, cut a ragged two- by eight-inch hole, a two-inch triangular hole, a 1/2- by 2-inch hole, two 1-inch triangular holes, a 1/4- by 1-inch hole, four 1-inch-square holes, six 1/2-inch-diameter holes, and nineteen holes of less than 1/2-inch-diameter in wing inter-spar, bottom skin; cut a 3/4- by 3-inch hole, a 3/4-inch triangular hole, a 1/2- by 1-inch hole, and three 1/4-inch-diameter holes in rear spar web; cut a one-inch triangular hole, a 1/2- by 1-inch hole, two 1/2-inch triangular holes, and six holes of less than 1/4-inch diameter in inter-spar ribs.

NOTE: Damage from this round compounded with Round Number 6.

[redacted]

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

ROUND NUMBER: Eight SIMULATED ALTITUDE: Sixty thousand feet

DATE: 10 February 1955

ASSESSOR: M/Sgt. A. W. Hammer

SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside left wing tip, midway between front and rear spars, and two inches outboard of Station 831.

BLAST: Destroyed and/or peeled back left wing tip, top and bottom inter-spar skin, between Wing Stations 819 and 842; partially destroyed inter-spar rib at Station 831; buckled and ballooned (two inches maximum) inter-spar rib at Station 819; lightly buckled (one inch maximum) inter-spar rib at Station 842; buckled (one inch maximum) front and rear spar web including top and bottom angles between Stations 819 and 842; lightly ballooned wing tip, leading edge, top and bottom skin, from leading edge to front spar and between Stations 819 and 842; buckled and ballooned (one inch maximum) wing tip, top skin, between Stations 819 and 842; and from rear spar to twenty-four inches aft of same, ballooned (one inch maximum) wing tip, top and bottom skin, between front and rear spars and between Stations 842 and 850. Structural and/or projectile fragments cut: a 3/4- by 1-inch hole, a 1/2- by 1-inch hole, a 1/2-inch-square hole, and nine holes of less than 1/2-inch diameter in inter-spar rib at Station 842; cut: three 1/2-inch-diameter holes and six holes of less than 1/2-inch diameter in inter-spar rib at Station 819; cut: two 1/2-inch-diameter holes and four 1/4-inch-diameter holes in rear spar web; cut: a 1-inch triangular hole and a 1/4- by 1-inch hole in front spar web; cut: a ragged 1½- by 3-inch hole, a two-inch triangular hole, two 1- by 2-inch holes, two 1-inch-square holes, a 1/2-inch-diameter hole, and nine holes of less than 1/2-inch diameter in wing tip, top and bottom skin, between Stations 842 and 850.

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

CONFIDENTIAL

ROUND NUMBER: Nine

DATE: 10 February 1955

ASSESSOR: M/Sgt. A. W. Hammer

SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside left wing, ten inches aft of rear spar, and ten inches outboard of Wing Station 723.

SIMULATED ALTITUDE: Sixty thousand feet

BLAST: Partially destroyed, tore loose and peeled back left wing, trailing edge, top and bottom skin, and structures from rear spar through trailing edge and between Wing Stations 699 and 751; buckled (two inches maximum) and tore loose tail ribs at Stations 721 and 747; destroyed tail ribs at Stations 731 and 741; ballooned (1/2-inch maximum) rear spar web between Stations 721 and 747. Structural and/or projectile fragments: cut three 1/2-inch-diameter holes and six 1/4-inch-diameter holes in rear spar web; cut a 1/2- by 1-inch hole, ten 1/2-inch-diameter holes, and twenty holes of less than 1/2-inch-diameter in tail ribs at Stations 721 and 747; cut a 3/4-inch triangular hole, three 1/2-inch-square holes and 13 holes of less than 1/4-inch-diameter in tail ribs at Stations 751 and 761.

CONFIDENTIAL

STATIC FIRING AGAINST AIRCRAFT-TYPE STRUCTURE

CONFIDENTIAL

ROUND NUMBER: Ten

DATE: 1- February 1955

ASSESSOR: M/Sgt. A. W. Hammer

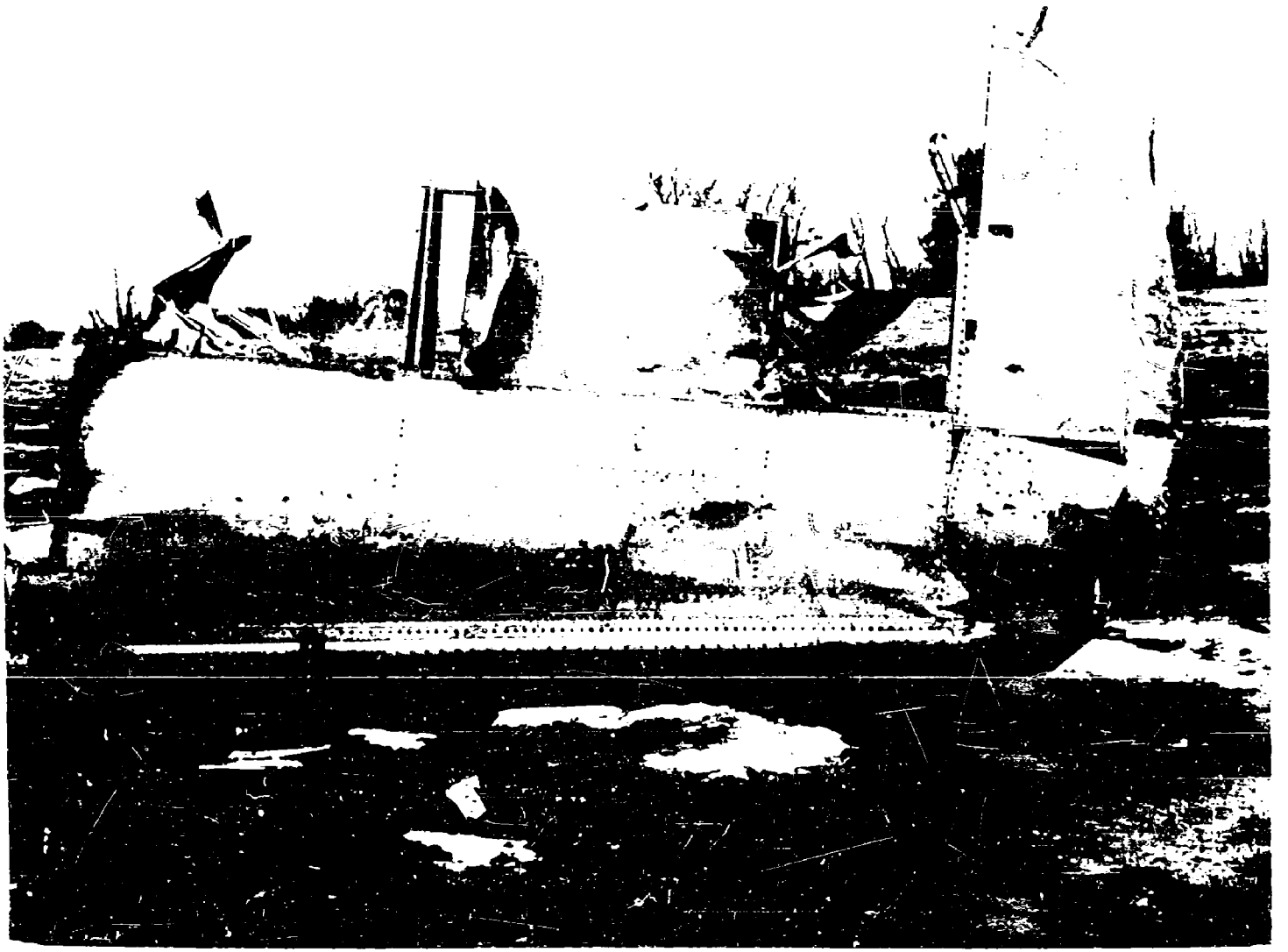
SHELL TYPE: 20mm, HEI, T282E1, Statically Detonated

AIRCRAFT: B-29 Outer Wing Panel, Outboard of Station 699

LOCATION OF CHARGE: Inside left wing, ten inches aft of rear spar, and six inches outboard of Wing Stations 795.

SIMULATED ALTITUDE: Sixty thousand feet

BLAST: Destroyed and/or peeled back left wing, trailing edge, top and bottom skins and structures from rear spar to trailing edge and from six inches inboard of Wing Stations 795 and 819; destroyed tail ribs at Stations 800 and 810; fifty per cent severed and buckled (two-inch maximum) tail rib at Station 819. Buckled (one inch maximum) tail rib at Station 795, ballooned (eight inches maximum) and tore loose trailing edge, top and bottom skin, including tail ribs from rear spar to trailing edge and from Station 747 to six inches inboard of Station 795. Ballooned (1/4-inch maximum) rear spar web between Stations 795 and 819. Structural and/or projectile fragments: cut a 1/4- by 1/2-inch hole, four 1/4-inch-diameter holes and one hole of less than 1/4-inch diameter in rear spar web; cut a 1/2-inch triangular hole, a 1/4- by 1-inch hole, three 1/2-inch-diameter holes, and twelve holes of less than 1/2-inch-diameter in tail rib at Station 819; cut a one-inch by 1/2-inch hole, two 1/2-inch-diameter holes, two 1/4- by 3/4-inch holes, and six holes of less than 1/2-inch-diameter in tail rib at Station 795, cut two 3/4-inch-square holes, three 1/2-inch triangular holes, a 1/4- by 1-inch hole, and fourteen holes of less than 1/4-inch-diameter in tail rib at Station 721; cut a 1/2- by three-inch hole, a 1/2- by 1-inch hole, two 1-inch-square holes, six 1/2-inch-diameter holes and numerous holes of less than 1/2-inch-diameter in wing, trailing edge, bottom skin; cut a 1/2- by two-inch hole, a 1/2-inch-diameter hole, a 1/4- by 3/4-inch hole, and three holes of less than 1/4-inch-diameter in wing, trailing edge, top skin.

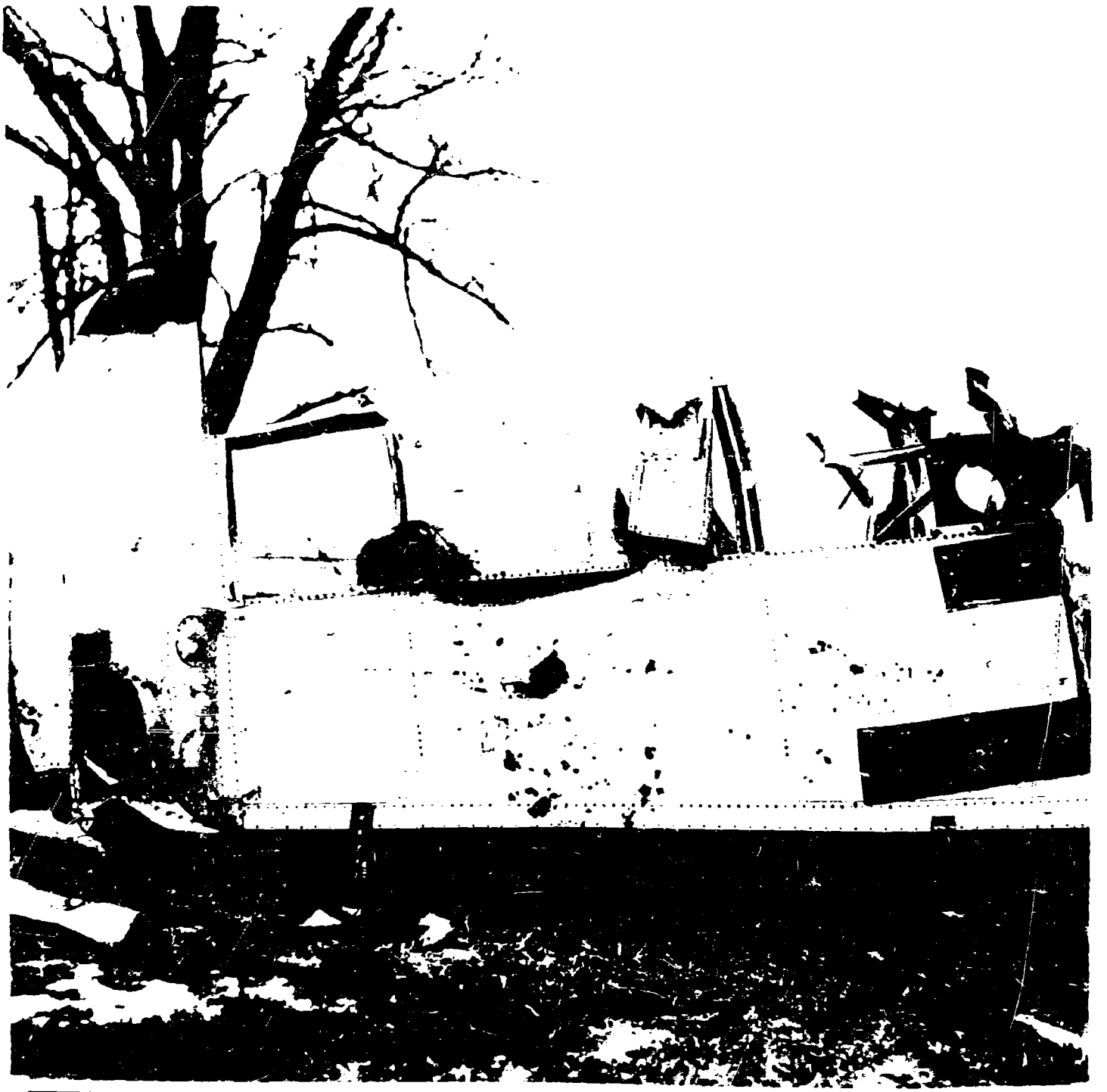


B6642 ABERDEEN PROVING GROUND 16 February 1955

Project No. TB3-0438. Static Blast, 20mm vs B-29 Wing.
20mm Static Blast at sea level within B-29 wing section.

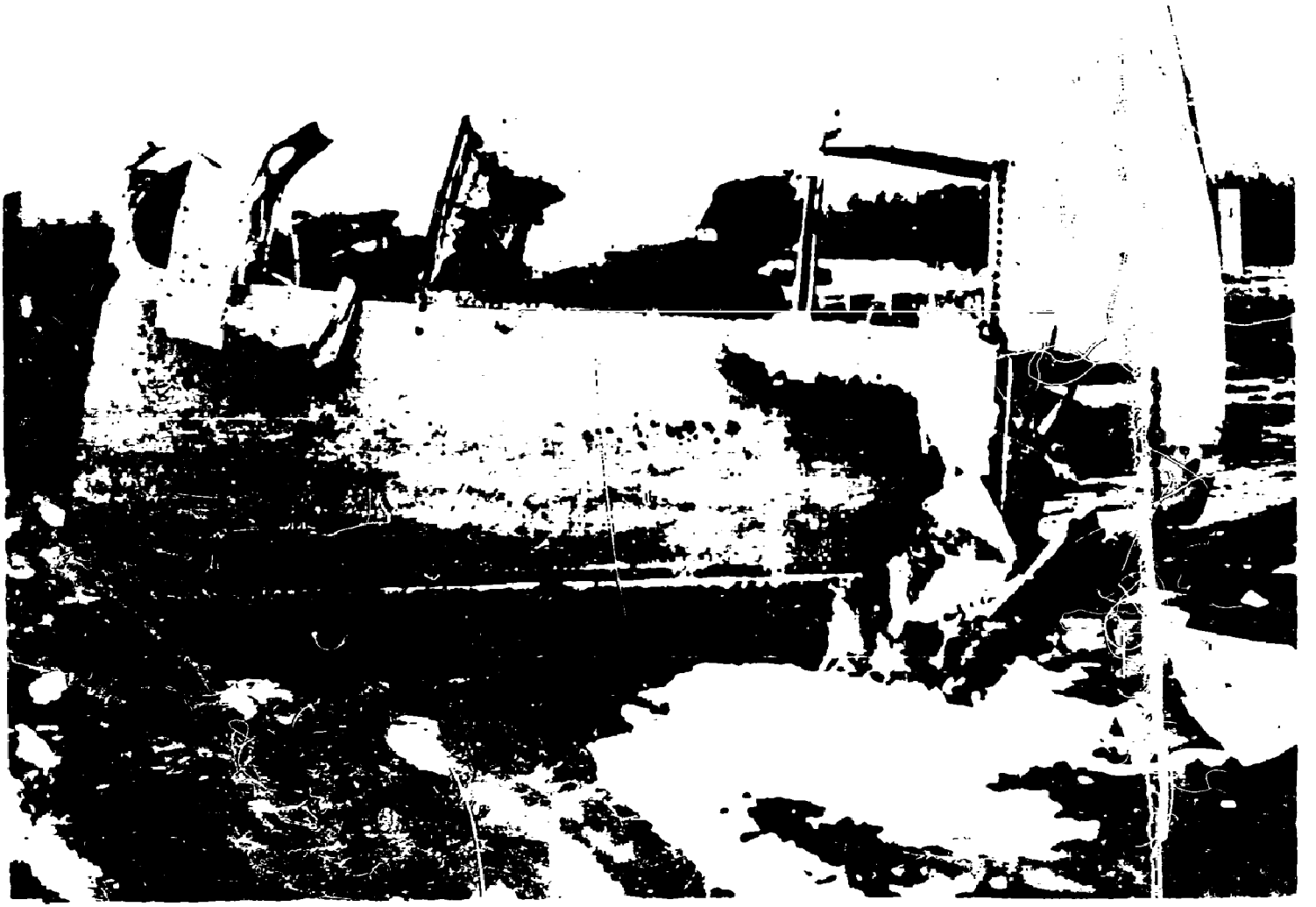
B6643 ABERDEEN PROVING GROUND 16 February 1955

Project No. T33-0438. Static Blast, 20mm vs B-29 Wing.
20mm Static Blast at sea level within B-29 wing section.



B6644 ABERDEEN PROVING GROUND 16 February 1955

Project No. TB3-0438. Static Blast, 20mm vs B-29 Wing.
20mm Static Blast at 60,000 ft. simulated altitude within B-29 wing section.



B6645 ABERDEEN PROVING GROUND 16 February 1955

Project No. TB3-0438. Static Blast, 20mm vs B-29 Wing.
20mm Static Blast at 60,000 ft. simulated altitude within B-29 wing section.